JOURNAL

OF THE

ROYAL
SOCIETY OF ARTS

VOLUME LVI.

FROM NOVEMBER 22, 1907, TO NOVEMBER 13, 1908.

LONDON:

PUBLISHED FOR THE SOCIETY BY GEORGE BELL AND SONS,
YORK HOUSE, PORTUGAL STREET, LINCOLN'S INN FIELDS, W.C.

1908.

Journal of the Society of Arts.

No. 2,870. VOL. LVI.

FRIDAY, NOVEMBER 22, 1907.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

ONE-HUNDRED-AND-FIFTY-FOURTH SESSION, 1907-8.

SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One-hundred-and-Fifty-Fourth Session was held on Wednesday Evening, the 20th of November, when an Address was delivered by Sir STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., Vice-President and Chairman of the Council.

MEETINGS PREVIOUS TO CHRISTMAS.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

NOVEMBER 27.—The HON. SIR JOHN A. COCKBURN, K.C.M.G., "The Franco-British Exhibition, 1908." The RIGHT HON. VISCOUNT SELBY, P.C., K.C., will preside.

DECEMBER 4.—SIR EDWARD W. BRABROOK, C.B., "Old Age Pensions." SIR WILLIAM BOUSFIELD, M.A., LL.D., Member of the Council, will preside.

„ 11.—SIR WILLIAM RAMSAY, K.C.B., Ph.D., LL.D., Sc.D., F.R.S., "Radio-active Phenomena." (Aldred Lecture.) SIR STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., Chairman of the Council, will preside.

„ 18.—MONSIEUR LUCIEN HUBERT, Député des Ardennes, "The Rôle of France in West Africa."

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

DECEMBER 12.—REGINALD GILBERT, F.Z.S., late of Bombay, "Big Game in India." The RIGHT HON. LORD HARRIS, G.C.S.I., G.C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evening, at 8 o'clock:—

DECEMBER 17.—LEWIS FOREMAN DAY, F.S.A., "How to Make the Most of a Museum." SIR ASTON WEBB, R.A., F.R.I.B.A., will preside.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

Friday evenings, at 8 o'clock:—

NOVEMBER 29.—JOHN SCOTT HALDANE, M.A., M.D., M.R.C.P. (Edin.), F.R.S., "The Hygiene of Work in Compressed Air (Diving, Caisson Work, Sub-aqueous Tunnelling, &c.). HERBERT LOUIS SAMUEL, M.P., Under-Secretary of State for the Home Department, will preside.

DECEMBER 13.—PROFESSOR THOMAS OLIVER, M.D., "Industrial Poisons—Lead and Phosphorus, with special reference to Lucifer Match Making."

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

CONRAD BECK, F.R.M.S., "The Theory of the Microscope." Four Lectures.
November 25, December 2, 9, 16. (For Syllabus see Page 22.)

MEETINGS AFTER CHRISTMAS.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock (dates not fixed):—

C. E. KENNETH MEES, D.Sc., F.C.S., "Screen-Plate Processes of Colour Photography."

H. S. HELE-SHAW, LL.D., F.R.S., and DOUGLAS MACKENZIE, "The Problem of Road Construction with a view to Present and Future Requirements."

A. S. JENNINGS, "Recent Improvements in Decorators' Materials."

CLAYTON BEADLE, "The Underground Water Supplies of the Thames Basin."

F. MARTIN DUNCAN, "Industrial Entomology: the Economic Importance of a Study of Insect Life."

LOUDON M. DOUGLAS, "Modern Dairy Practice."

AUGUSTE E. GAUDRON, "War Balloons."

HARRY HILLMAN, "Siam and its People."

ROBERT BUCHANAN (President, Staffordshire Iron and Steel Institute), "The Application of Science to Foundry Work."

WILLIAM MARTIN, M.A., LL.D., "The Law of Treasure Trove."

ERNEST R. MATTHEWS, F.R.S.E., Assoc.M.Inst.C.E., "The Use of Reinforced Concrete in Engineering and Architectural Construction in America."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 16, February 13, March 12, April 30, May 21.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 28, February 25, March 24, April 7.

APPLIED ART SECTION.

Tuesdays, at 4.30 or 8 o'clock:—

January 21, February 18, March 31, April 28, May 26.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

HENRY HARDINGE CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." Six Lectures.
January 20, 27, February 3, 10, 17, 24.

PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." Four Lectures.
March 9, 16, 23, 30.

WILLIAM BURTON, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.
May 4, 11, 18.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

Dates not fixed:—

JOHN SCOTT HALDANE, M.A., M.D., M.R.C.P. (Edin.), F.R.S., "The Removal of Dust and Fumes in Factories."

W. E. GARFORTH, President of the Colliery Proprietors' Association of Great Britain, "The Dangers of Coal Dust and their Prevention."

WILLIAM BURTON, F.C.S., Chairman of the Joint Committee of Pottery Manufacturers of Great Britain, "The Hygiene of the Pottery Trade."

MISS NETTIE ADLER, Hon. Secretary to the Committee on Wage Earning Children, "Child Workers and Wage Earners."

HOWARD LECTURES.

Thursday evenings, at 8 o'clock:—

H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." Three Lectures. March 19, 26, April 2.

JUVENILE LECTURES.

Wednesday evenings, January 1 and 8, 1908, at 5 o'clock.

F. MARTIN DUNCAN, "The Scientific Applications of the Cinematograph."

CONVERSAZIONE.

The Annual Conversazione of the Society will probably be held on Tuesday, June 30th, 1908. Each member is entitled to a card for himself, and one for a lady.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department or science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

COLONIAL SECTION.—The Section was formed in 1874 under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies. Four or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886, for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of from two to six Lectures.

ADDITIONAL LECTURES.—Special Courses of Lectures are occasionally given.

HOWARD LECTURES.—The bequest of Mr. Thomas Howard (1872) is now devoted to occasional courses of lectures on motive-power and its applications. A course of three lectures will be delivered this session under this trust.

SHAW LECTURES.—A series of six lectures on Industrial Hygiene will be given this session under the Shaw bequest, two before Christmas and the others later in the session.

ALDRED LECTURE.—The bequest of the late Dr. Aldred has been devoted to the establishment of an Annual Lecture. The first lecture will be given this session.

JUVENILE LECTURES.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

MEMBERSHIP.—Candidates for election must be proposed by three members, one of whom at least must sign the proposal form on personal knowledge, or they can be nominated by the Council. The Annual Subscription is Two Guineas, commencing from any quarter-day. Life Membership is Twenty Guineas. There is no entrance fee.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted by signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—Examinations, founded in 1853, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal elements of Commercial Education, and Music. Full particulars of the Examinations can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room is open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which Members are invited, each Member receiving a card for himself and a lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid. There is no Entrance Fee.

Every Member whose subscription is not in arrear is entitled:—

- To be present at the Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.
- To be present and vote at all General Meetings of the Society.
- To be present at the Cantor and other Lectures, and to introduce one visitor.
- To have personal free admission to all Exhibitions held by the Society at its house in the Adelphi.
- To be present at all the Society's *Conversazioni*.
- To receive a copy of the weekly *Journal* published by the Society.
- To the use of the Library and Reading-room.

Candidates for Membership are proposed by Three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary*.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1907-1908. It is issued subject to any necessary alterations:—

NOVEMBER, 1907.

1	F	
2	S	
3	**S**	
4	M	
5	Tu	
6	W	
7	Th	
8	F	
9	S	
10	**S**	
11	M	
12	Tu	
13	W	
14	Th	
15	F	
16	S	
17	**S**	
18	M	
19	Tu	
20	W	Opening Meeting of the Session.
21	Th	
22	F	
23	S	
24	**S**	
25	M	Cantor Lecture I. 1
26	Tu	
27	W	Ordinary Meeting
28	Th	
29	F	Shaw Lecture
30	S	

DECEMBER, 1907.

1	**S**	
2	M	Cantor Lecture I. 2
3	Tu	
4	W	Ordinary Meeting
5	Th	
6	F	
7	S	
8	**S**	
9	M	Cantor Lecture I. 3
10	Tu	
11	W	Ordinary Meeting
12	Th	Indian Section
13	F	Shaw Lecture
14	S	
15	**S**	
16	M	Cantor Lecture I. 4
17	Tu	Applied Art Section
18	W	Ordinary Meeting
19	Th	
20	F	
21	S	
22	**S**	
23	M	
24	Tu	
25	W	CHRISTMAS DAY
26	Th	*Bank Holiday*
27	F	
28	S	
29	**S**	
30	M	
31	Tu	

JANUARY, 1908.

1	W	Juvenile Lecture I.
2	Th	
3	F	
4	S	
5	**S**	
6	M	
7	Tu	
8	W	Juvenile Lecture II.
9	Th	
10	F	
11	S	
12	**S**	
13	M	
14	Tu	
15	W	Ordinary Meeting
16	Th	Indian Section
17	F	
18	S	
19	**S**	
20	M	Cantor Lecture II. 1
21	Tu	Applied Art Section
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	**S**	
27	M	Cantor Lecture II. 2
28	Tu	Colonial Section
29	W	Ordinary Meeting
30	Th	
31	F	

FEBRUARY, 1908.

1	S	
2	**S**	
3	M	Cantor Lecture II.
4	Tu	
5	W	Ordinary Meeting
6	Th	
7	F	
8	S	
9	**S**	
10	M	Cantor Lecture II.
11	Tu	
12	W	Ordinary Meeting
13	Th	Indian Section
14	F	
15	S	
16	**S**	
17	M	Cantor Lecture II. 5
18	Tu	Applied Art Section
19	W	Ordinary Meeting
20	Th	
21	F	
22	S	
23	**S**	
24	M	Cantor Lecture II. 6
25	Tu	Colonial Section
26	W	Ordinary Meeting
27	Th	
28	F	
29	S	

MARCH, 1908.

1	**S**	
2	M	
3	Tu	
4	W	Ordinary Meeting
5	Th	
6	F	
7	S	
8	**S**	
9	M	Cantor Lecture III. 1
10	Tu	
11	W	Ordinary Meeting
12	Th	Indian Section
13	F	
14	S	
15	**S**	
16	M	Cantor Lecture III. 2
17	Tu	
18	W	Ordinary Meeting
19	Th	Howard Lecture 1
20	F	
21	S	
22	**S**	
23	M	Cantor Lecture III. 3
24	Tu	Colonial Section
25	W	Ordinary Meeting
26	Th	Howard Lecture 2
27	F	
28	S	
29	**S**	
30	M	Cantor Lecture III. 4
31	Tu	Applied Art Section

APRIL, 1908.

1	W	Ordinary Meeting
2	Th	Howard Lecture 3
3	F	
4	S	
5	**S**	
6	M	
7	Tu	Colonial Section
8	W	Ordinary Meeting
9	Th	
10	F	
11	S	
12	**S**	
13	M	
14	Tu	
15	W	
16	Th	
17	F	GOOD FRIDAY
18	S	
19	**S**	EASTER SUNDAY
20	M	*Bank Holiday*
21	Tu	
22	W	
23	Th	
24	F	
25	S	
26	**S**	
27	M	
28	Tu	Applied Art Section
29	W	Ordinary Meeting
30	Th	Indian Section

MAY, 1908.

1	F	
2	S	
3	**S**	
4	M	Cantor Lecture IV. 1
5	Tu	
6	W	Ordinary Meeting
7	Th	
8	F	
9	S	
10	**S**	
11	M	Cantor Lecture IV. 2
12	Tu	
13	W	Ordinary Meeting
14	Th	
15	F	
16	S	
17	**S**	
18	M	Cantor Lecture IV. 3
19	Tu	
20	W	Ordinary Meeting
21	Th	Indian Section
22	F	
23	S	
24	**S**	
25	M	
26	Tu	Applied Art Section
27	W	Ordinary Meeting
28	Th	
29	F	
30	S	
31	**S**	

JUNE, 1908.

1	M	
2	Tu	
3	W	
4	Th	
5	F	
6	S	
7	**S**	WHIT SUNDAY
8	M	*Bank Holiday*
9	Tu	
10	W	
11	Th	
12	F	
13	S	
14	**S**	
15	M	
16	Tu	
17	W	
18	Th	
19	F	
20	S	
21	**S**	
22	M	
23	Tu	
24	W	Annual General Meeting
25	Th	
26	F	
27	S	
28	**S**	
29	M	
30	Tu	Conversazione

The Cantor, Shaw, Howard, and Aldred Lectures will commence at Eight o'clock.

The Ordinary Meetings will commence at Eight o'clock.

The Meetings of the Indian Section and the Colonial Section will commence at Half-past Four o'clock.

The Meetings of the Applied Art Section will commence at Half-past Four or Eight o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Five o'clock.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 20th, 1907; Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Chairman of the Council, in the chair.

The following members were proposed for election as members of the Society:—

Abrahams, Ernest Goldsmid, F.S.S., The Chesnuts, Brondesbury-park, N.W.

Almenräder, Gustav Hermann, Violeta, Manor-road, High Barnet, Herts.

Ampthill, Lord, G.C.S.I., G.C.I.E., Milton Ernest-hall, Bedford.

Armstrong, Major Samuel Treat, M.D., Ph.D., 144, East 37th Street, New York City, U.S.A.

Athim, Samuel, Assoc.M.Inst.C.E., Executive Engineer, Public Works Department, Dhukwan P.O., *viâ* Babina (G.I.P. Railway), India.

Bampfylde, C. A., Larethan, Bodmin, Cornwall.

Barber, Frank Peto, Claremont-house, Hooley-green, Halifax.

Barlass, Thomas, M.R.San.I., 45, College-street, S.E.

Batsford, Herbert, 94, High Holborn, W.C., and 35, Springfield-road, N.W.

Bell, Henry Purdon, M.Inst.C.E., Kent Canal, Campbellford, Ontario, Canada.

Bennett, William Hart, Government-house, Nassau, Bahamas, and Royal Societies Club, St. James's-street, S.W.

Benton, John, C.I.E., M.Inst.C.E., Belvedere, Simla, Punjab, India.

Buchanan, Robert, The Hawthorns, Sutton-road, Walsall.

Cohen, Abner, J.P., Krugersdorp, Transvaal, South Africa.

Copland, Fitz-John Henry, J.P, Mount Rodney Estate, St. Patrick's, Grenada, British West Indies.

Das, Madhu Sudan, C.I.E., Katak, India.

Das, Miss Shaila Bala, care of M. S. Das, C.I.E., Katak, India.

Davies, C. Gilbert, Messrs. Davies and Thomas, The Bund, Shanghai, China.

Deo, Rajendra Narayan Bhanja, Raja of Kanika, Katak, India.

Dukes, Thomas William, Vryheid, Natal, South Africa.

Fabarius, Erich, Messrs. Knoop and Fabarius, Bremen, Germany.

Ford, Richard Thomas, 42, Dyne-road, Brondesbury, N.W.

Frame, David Bruce, Napier, New Zealand.

Galton, Lady Marianne Douglas, Himbleton Manor, Droitwich, and 12, Chester-street, S.W.

Gladstone, Arthur Steuart, 78, Onslow-gardens, S.W.

Gupta, Jogendra Nath Das, B.A., Hooghly College, Chinsurah, Bengal, India.

Heather, Henry James Shedlock, B.A., M.Inst.C.E., Messrs. H. Eckstein and Co., P.O. Box 149, Johannesburg, Transvaal, S. Africa.

Holton, Henry D., A.M., M.D., State Board of Health, Brattleboro, Vermont, U.S.A.

Hossein, Md. Mufazzal, Camp Golaghat, Assam, India.

Hunt, Henry J, The Priory, Wimbledon-common, S.W.

Hurd, Milner, A.M.I.Mech.E., Laud chambers, Reading.

Iwai, Tatsumi, Civil Affairs Bureau, Taihoku, Formosa, Japan.

Johnson, Alfred Latunde, Central Province, Warri, Southern Nigeria.

Keeley, David Herbert, Department of Public Works, Ottawa, Ontario, Canada.

Kermode, John Jonathan, M.I.Mech.E., Imperial-chambers, 62, Dale-street, Liverpool.

Khoo Chong Lye, Raub, Pahang, Federated Malay States

Knocker, Fred W., Perak State Museum, Taiping, Federated Malay States.

Kyaw, Moung Ba, 12A, Mecklenburgh-square, W.C.

Lake, Charles Sidney, A.M.I.Mech.E., 5, Falkland-avenue, Church-end, Finchley, N.

Lim Cheng Law, Sungei Pinang, Penang, Straits Settlements.

McGaw, Andrew Kidd, Burnie, Tasmania.

McGhee, Miss Evelyn P., 82, Porchester-terrace, W.

Marshall, Archibald McLean, Crogen, Corwen, North Wales.

Miles, Roslyn, 79, Sterndale-road, West Kensington, W.

Milne, Oswald P., 16, Great James-street, Bedford-row, W.C.

Otagiri, Tadawo, 15, West Bolton-gardens, S.W.

Pearson, Mrs. Kate Hyde, 16, Duke-street, Piccadilly, W.

Peddar, Sydney Hampden, 6, Kensington Palace-gardens, W.

Phillips, Mrs. Lionel, Tylney Hall, Winchfield, Hants.

Pitt, Colonel William, R.E., 78 Eccleston-square, S.W.

Plante, Stanley Gedge, Assoc.M.Inst.C.E., 24, Worple road, Wimbledon, S.W.

Pollock, Sir Frederick, Bart., D.C.L., M.A., LL.D., 21, Hyde-park-place, W.

Richert, J., 44, Cambridge-street, Hyde-park-square, W.

Ritch, L. W., 28, Queen Anne's-chambers, Broadway, Westminster, S.W.

Robertson, John, A.C.P., The School-house, Strachur, Greenock, N.B.

Saito, Vice-Admiral Baron, I.J.N., Navy Department, Tokyo, Japan.

Sakō, T., President, Japan Sugar Company, Sunamura, Minami Kalsushika Gori, Tokyo, Japan.

Setti, S. Venkata Subba, B.A., Chikmagalur, Mysore Province, India.

Silberstein, Willy, 27, Clement's-lane, E.C.
Smithers, F. O., 171, Adelaide-road, South Hampstead, N.W.
Smythe, Captain Alan, Milford-lodge, Craven Arms, Shropshire.
Stackhouse, J. Foster, 95, High-street West, Sunderland.
Stewart, Cecil G. G., 1, Clarendon-street, Warwick-square, S.W.
Swan, John Sidney, Wellington, New Zealand.
Talbot, P. A., B.A. (Oxon), The Cottage, Abbots Morton, Worcestershire.
Tucker, William, Regina, Saskatchewan, Canada.
Walford, Leopold H. G., 48, Cornhill, E.C., and 14, Park-place-villas, W.
Walpole, E. Horace, 89, New Bond-street, W.
Waring, Alfred, M.B., M.R.C.S., L.R.C.P., 7, East Circus-street, Nottingham.
Waring, Captain Antony Henry, M.R.C.S., Lahore Encampment, Punjab, India.
Waring, Henry Robert, M.Inst.C.E., 127, San Miguel, Palma de Mallorca, Spain.
White, Frank Faulder, F.R.C.S., Coventry.
Worsley, Harold, Moor Plantation, Ibadan, Lagos, West Africa.

The CHAIRMAN delivered the following Address—

LORD CLIVE AND HIS PART IN THE FOUNDATION OF THE INDIAN EMPIRE.

I explained in my address last year, the ancient rule of the Society which imposes on the Chairman the duty, independent of his own predilections, of delivering an address at the opening meeting of each session; and I pointed out how this address had developed from being a mere appreciation of the work of the past year, and a forecast of that for the future, into an occasion for the Chairman to express his thoughts on some subject in which he took special interest, and might therefore hope to excite the interest of his audience. The subject I have chosen for this evening is "Lord Clive and his part in the foundation of the Indian Empire;" and there are three reasons which have co-operated in influencing my selection. The first is that this being the 150th anniversary of the victory of Plassey, has rightly been seized by Lord Curzon as the fitting opportunity for issuing his stirring appeal to the nation and endeavouring to awaken interest in Clive's work, and to establish some worthy memorial of his great services to this country. The second reason is personal to myself, an ancestral connection which I will touch upon later, and owing to which I have been led to take a special interest in Clive's career; and the third reason is Clive's connection with the Society of Arts.

Not only was Clive a member of this Society, he was one of the few commoners (the great William Pitt being another) who undertook to subscribe five guineas a year to the Society. After the victory of Plassey, the Society, who had about that time determined to try and improve the art of die-sinking, struck a medal in Clive's honour. A full account of this and other medals will be found in a paper contributed by Mr. Wheatley to the Society's *Journal* of June 24th, 1887; but it may be said briefly that the medal was designed by John Pingo, that on the obverse is a Victory seated on an elephant, with the words "Victory at Plassey, Clive commander;" and underneath the date (which is wrongly given as 1758 instead of 1757), and the Society's initials. On the reverse is Clive as a Roman general, holding a sceptre, surmounted by a lion in his left hand, and with his right hand presenting to Mir Jaffir another sceptre, surmounted by a dolphin. The inscription on this side is "Injuries attoned, Privilege augmented, Territory acquired;" and in the space below are the words, "a soubah given to Bengal." Here, again the date is given as 1758. I gather that the medal was not struck till 1765, and there is no record of its presentation. Clive's second visit to Bengal would probably have prevented any public presentation. A copy of the medal is here on the table if anyone would like to see it. The design is not altogether happy, the designer having drawn the elephant from the depths of his self-consciousness rather than from nature, and having given the animal a short curly tail like a pig, and outward-bending hocks like those of a horse, instead of inward-bending knees like those of a man. The Victory, too, is out of proportion to the complacent animal she is seated on. None the less it is an interesting record of Clive's connexion with the Society, and of the Society's appreciation of his merits.

My other reason—an ancestral connection—is this. Clive's mother was a Miss Gaskell, and her sister was the first wife of my great-grandfather, and for some reason not explained, Clive was transferred from his own home at the age of 3, and for the next 7 or 8 years was entirely brought up by my ancestor, in his house near Manchester. It is from the few surviving letters of Mr. Daniel Bayley that most of the glimpses which we have of Clive's early boyhood are derived.

There are later legends of his schoolboy life collected by Mr. Beaufoy, who some years after Clive's death published an account of him in the "Biographia Britannica," and these legends are all to the same purport of showing that he was unruly, combative, and masterful as a boy, albeit one of his early schoolmasters predicted his future fame. I attach more importance to the evidence of Mr. Bayley, who writing of his charge when Clive was only seven years old said, "This fighting, to which he is out of measure addicted, gives his temper such a fierceness and imperiousness that he flies out on every trifling occasion. For this reason I do what I can to suppress the hero in him, that I may help forward the more valuable qualities of meekness, benevolence and patience." Fortunately perhaps for the world, if not for Clive, my revered ancestor achieved only very partial success. Clive was benevolent, he acquired a limited measure of patience, but meek he never was, and assuredly the hero in him was not suppressed. Clive's aunt, Mrs. Bayley, died in 1735 when he was ten years old, and in the following year he went back to his own people at Styche in Cheshire, but the close connection with the Bayley family was maintained, and one of his earliest letters from Madras was written to Mr. Bayley, full of home sickness and longing to be back among his friends at Manchester. I may mention here that Clive's early letters from India give me the impression of a very imperfectly educated mind. There are lapses in grammar and spelling, and the language is stilted and artificial, but as he goes on in life his style steadily improves, it becomes direct, plain-spoken, and forcible, and while indulging occasionally in conventional Latin tags, he introduces sometimes more recondite allusions to classical history, and shows that during his solitary and morose days as a commercial clerk at Madras he made good use of his access to Governor Morse's library, and educated himself to something more than an equality with his fellows. It was at the age of 18 that Clive went out to Madras as a writer in the East India Company's service. His duties were those of a clerk in a large commercial business, and he found them unbearable. But before dealing with Clive's work, I must, as briefly as possible, explain the general conditions under which that work had to be done, conditions which rendered Clive's success not only possible, but, given his genius, inevitable. The materials of success were there. Clive was the man of his generation capable of developing them.

If anyone wishes to acquire a comprehensive view of the real position of the East India Company and its settlements in the early part of the eighteenth century, and to understand the vital importance to the nation of the struggle that the Company were making against their European rivals for the Indian trade, I recommend the study of Sir Alfred Lyall's book on "British Dominion in India." As an historical examination, not of details, but of tendencies and forces, both political and commercial, which rendered the long duel between France and England throughout a great portion of that century inevitable, I know nothing so helpful, so illuminating, so decisive. He shows how in the beginning the rivalry was a trade rivalry, how after the Dutch had succeeded in wresting the leadership in the Eastern trade from the Portuguese, and had more than held their own against us, the long wars between the French and Dutch during the latter portion of the seventeenth century had enfeebled both, leaving England as the *tertius gaudens* in a fairly good position just at the time when the Mogul Empire, under Aurungzeb, was beginning to crumble. He shows from Bernier, from Leibnitz, from the action of the East India Company, under Sir Josiah Child, and he might have added Manusci in the "Storia de Mogor" to his list of witnesses, that the weakness of the Oriental powers, even of the Mogul Empire, was well understood, and the possibility of monopolising Oriental trade by means of Oriental conquest was already in the air, and he quotes from Sir W. Davenant these two pregnant sentences, "Whatever country can be in full possession of the Indian trade will give law to all the commercial world;" and still referring to our rivalry with Holland in the East, "If our foreign business were enlarged to the utmost extent of which it is capable, we should thereby acquire such wealth and power as that England with its proper forces might be able to deal with any nation whatsoever," and become like Rome the head of a vast dominion. This was written two centuries ago.

Sir Alfred Lyall sweeps away the notion that the English acquired their dominion in India in a fit of absence of mind; he shows that the tendency (at all events in theory, for in action the English were behindhand) already was to follow the example of the Dutch, who had adopted from the Portuguese the policy of

making their settlements self-protective by fortifications and strong garrisons, of acquiring territory, and of treating their acquisition as held on behalf of the sovereign European power, and explains that as the Mogul Empire lost its authority, it might have been foreseen that the power of the foreign companies would steadily expand, that the expanding companies would come into collision with each other, and that the victorious European company would have little to fear from native adversaries, and would acquire uncontestable ascendancy in the country.

At the time when Clive went to India the position was this. The Dutch Company were shifting their business from the Indian coast eastwards. The French, who were our nearest neighbours on the Coromandel Coast, were beginning to adopt a new policy, and emerging from the status of peaceful traders into that of competitors for territorial dominion, and we had to follow their lead.

The necessity of the East India Company being something more than a trading concern, if it was to carry out even its trading business successfully, had for many years been clearly recognised. Its early charters were mainly concerned with regulating it as a trading monopoly, but after half a century these had to be strengthened by the legal recognition of it as a body that would have both to fight for its existence against external enemies, and to provide for the orderly regulation of its own little territories. Accordingly we find that various charters framed during the reigns of Charles II. and James II. gave the Company authority to make war against non-Christian powers, to fit out ships, raise troops, give commissions to military and naval officers to command such troops, to erect fortifications, and to coin money, also to establish a municipality in Madras. The charter of 1726 established or reconstituted Mayor's Courts in Calcutta, Madras, and Bombay. These were courts dealing with civil disputes, the Governor and four senior members of Council being made Justices of the Peace and forming a court of quarter sessions for the more serious criminal offences.

The first recorded step in the formation of the Company's army is to be found in the charter of 1669 which transferred the island of Bombay from the Crown to the Company and allowed such of the King's officers and soldiers of the Crown as were then on the island to take service with the Company. These were the nucleus of the Company's first European regiment of Bombay Fusiliers. But for practical purposes the Company's permanent army, as Sir G. Chesney tells us, dates from 1748, in consequence of the war with France; a small body of sepoys was then raised at Madras, and, to some extent, drilled and disciplined, following the French initiative; and these, with a small European force, composed mainly of sailors, were placed under Major Lawrence, who received a commission from the Company to command them. Sir G. Chesney has pointed out that in its earliest wars the Company depended mainly on its European troops for fighting purposes. The sepoys then, and indeed till Clive took them in hand, were little better than those of the native powers. They were enlisted anyhow, and though supplied with European arms were dressed and equipped in native fashion, served under any native officer, who might happen to bring them into the service, and changed their service with the rapidity of the condottieri of the fifteenth century in Italy. After one of Clive's earliest victories a body of 300 sepoys came over from the enemy to take service under him. In fact desertions play a large part in the history of the period. It was to English deserters to the French that Clive owed his wound at Samiáveram; and the number of French deserters in our army was recognised as an appreciable danger by the Council of War before Plassey, and indeed it was to them mainly that the very serious mutiny of 1765 was due. Clive, when he had to raise *Sepahi* battalions in Bengal, not only armed them but equipped and clothed them like British soldiers, placed them under European officers to command them, and gave European non-commissioned officers to drill and instruct them. The men were of all castes and races, many Pathans and Rohillas, some Rajputs and Jats, but mostly Mohammedans. They were largely adventurers, whom the constant wars in Bengal in the time of Alaverdi Khan had brought down from the Upper Provinces; and if anyone wishes to know the terrible state of continuous war and devastation that existed in Bengal previous to Clive's time, I recommend him to read Orme's matter of fact narrative of the reign of Alaverdi Khan. For ten years of his reign (and he was a keen soldier) the whole of Bengal west of Moorshedabad was annually raided by the Mahrattas, apart from internal rebellions and massacres, which were frequent, and the constant warfare ended in the cession of the

province of Orissa to the Mahrattas, who held it for nearly half-a-century. No wonder then that Clive found plenty of military adventurers to join his standard, and it was out of such materials that he formed the 1st Battalion of Bengal Native Infantry early in 1757, the famous Lal Paltan, and a second in August, 1757, a third in the following year, and when Clive returned to Bengal in 1766 the number had increased to 20 battalions. But this is anticipating, and I must go back to Clive where we left him as a commercial clerk in Madras.

Up to this time the Company's aspirations and labours in Madras had not gone beyond the proper business of a trading concern, but Dupleix at Pondichery had seen further into the future, had fortified his headquarters, had strengthened and improved his troops, and formed alliances with some of the neighbouring native chiefs who were constantly at war with each other. War between France and England broke out in 1744, and in the following year the French fleet, under La Bourdonnais, assisted by Dupleix's army from Pondichery, captured Madras. This led to Clive's exchanging the pen for the sword. There was very little need at the moment for commercial clerks; for officers there was very great need. Clive received a temporary commission from Major Stringer Lawrence, who noted his capacity as a soldier, and gave him rapid advancement and frequent opportunities for distinguishing himself.

Though it was not till 1751 that Clive's name was removed from the Civil List, on his getting a permanent commission as captain, yet for the next 12 years his life, except when on leave, was almost wholly given up to campaigning in the field. Incidentally the capture of Madras led to other far-reaching developments. For Dupleix once in possession of Madras declined altogether to cede it, as he had promised, to his titular overlord, the Nawab of the Karnatic. The latter (Anwaruddin) sent his son with a force of 10,000 men to take it. Dupleix (who never took the field himself) sent a force of 250 Europeans and 700 Sipahis to relieve the garrison under a Swiss officer, M. Paradis. The Nawab's army of ten thousand, and the relieving force of less than one thousand, met on the banks of the Adyar, and the latter charging after delivering but a single volley, caused the Nawab's army to flee panic-stricken and discomfited, and by this one victory changed the whole relative position between the European trading companies and the territorial sovereigns in India. As Malleson says :—

"Up to that time the superiority of the latter had never been disputed either by English or French. The representatives of both nations had been content to be the vassals of the Nawab of the Karnatic. The battle of San Thomé effected a revolution in this respect. Thenceforward the alliance of the Europeans came to be eagerly sought by every pretender to dominion. The revolution had been effected by the genius of Dupleix."

Yes, Dupleix had retaught the lesson which Alexander's legions had indicated 2,000 years before, of the comparative value of discipline as against numbers, but Clive lost no time in bettering the instruction. The official war between France and England was at an end, but the contest between the two nations continued to be carried on unofficially as the allies of one or other of the pretenders to the Nawabship of the Karnatic, the more so as the peace left each of the European trading companies with a large number of superfluous troops, costly to keep, but profitable to lend. And it was in this capacity as supporter of our candidate—Mohammed Ali—that Clive received his first independent command. He was deputed, at his own suggestion, to take Arcot, the capital of the other or French candidate, Chunda Sahib, with a view to relieve the pressure on Trichinopoly, where the English and Mohammed Ali were besieged and at their last gasp. Clive's force consisted of 200 English soldiers and 300 sepoys, and how effectually he performed his mission and for 50 days sustained the siege against the investing force of 10,000 men, strengthened by 150 of Dupleix's French soldiers, notwithstanding ruinous walls, untenable battlements, with only four officers, scanty provision and numerous casualties has been told in undying language by Macaulay, language which no one can read without a quickening of the pulse, and which I will neither quote at length nor attempt to emulate. One brief extract only I will repeat, both because it shows of what fidelity Indian troops are capable, and also because it bears witness to Clive's Napoleonic faculty of compelling the devotion and love of his men. Macaulay says :—

"During fifty days the siege went on. During fifty days the young captain maintained the defence with a firmness, vigilance, and ability which would have done honour to the oldest marshal in Europe. The breach, however, increased day by day. The garrison began to feel the pressure of hunger. Under such circumstances any troops, so scantily provided

with officers, might have been expected to show signs of insubordination, and the danger was peculiarly great in a force composed of men differing widely from each other in extraction, colour, language, manners, and religion. But the devotion of the little band to its chief surpassed anything that is related of the Tenth Legion of Cæsar, or of the Old Guard of Napoleon. The sepoys came to Clive, not to complain of their scanty fare, but to propose that all the grain should be given to the Europeans, who required more nourishment than the natives of Asia. The thin gruel, they said, which was strained away from the rice, would suffice for themselves. History contains no more touching instance of military fidelity or of the influence of a commanding mind."

Time will not allow of my following Clive in detail through the rest of this campaign, but it ended after a year of successful battles at Timeri, Arni, Kaveripak, Samiáveram, Paichanda and Volkonda, in the surrender of the French commanders; first of d'Auteuil, and then of Law, with the whole of the French forces—a complete defeat of Dupleix's schemes; but there is one episode so indicative of Clive's tenacity and readiness of resource in most difficult circumstances, that I will quote what Malleson says of it. It occurred at Kaveripak, where a large force, including 400 French soldiers, had laid a skilful ambush for Clive's forces marching from Vandalur. This is what Malleson says:—

"In the fight before Kaveripak we see Clive at his best. He had marched straight into the trap, and, humanly speaking, was lost. It was his cool courage, his calmness in danger, his clearness of mind in circumstances of extraordinary difficulty, his wonderful accuracy of vision, the power he possessed of taking in every point of a position, and of at once utilising his knowledge, that saved him. He was, I repeat, lost. He had entered the trap, and its doors were fast closing upon him. Bravely did his men fight to extricate him from the danger. Their efforts were unavailing. Soon it came about that the necessity to retreat entered almost every mind but his own. Even the great historian of the period, Mr. Orme, wrote that 'prudence counselled retreat.' But to the word prudence, Clive applied a different meaning. To him, prudence was boldness.

"He would think only of conquering, and he conquered. After four hours of fighting, all to his disadvantage, he resolved to act on the principle he had put into action when he first seized Arcot. He would carry the war into the enemy's position. By a very daring experiment he discovered that the rear of the wooded redoubt, occupied by the French, had been left unguarded. With what men were available, he stormed it; took the enemy by surprise, the darkness wonderfully helping him; and threw them into a panic. Of this panic he promptly took advantage; forced the Frenchmen to surrender; then occupied their strong position, and halted, waiting for the day. With the early morn he pushed on and occupied Kaveripak. The enemy had disappeared. The corpses of fifty Frenchmen, and the bodies of 300 wounded showed how fierce had been the fight. He had, too, many prisoners. His own losses were heavy; forty English and thirty Sipahis. But he had saved Southern India. He had completely baffled the cunningly devised scheme of Dupleix."

This was not the end of Dupleix. He made, in the following year, magnificent efforts to retrieve the position, and if his officers had been confronted with a less able soldier than Clive's old commander, Stringer Lawrence, he might have succeeded. But it was Clive's victories ending with the humiliating surrender of D'Auteuil and Law that led Dupleix's employers in France to decide on superseding him. He was recalled in 1755, and after nine years of humiliating efforts to obtain repayment of money advanced by him to the Company, he died in poverty and neglect in 1764.

A further attempt was made after war had again broken out between England and France in 1756 to oust the English from the Karnatic Coast. This was under Count Lally, who, with superior forces but with inferior intelligence and less capable officers, carried on an ineffectual campaign for two years, ending in the surrender of Pondichery and the capture of Lally, who, like Admiral Byng, was afterwards executed, and in the complete abandonment of French ambitions on the coast. To this victory, too, Clive largely contributed by sending from Bengal his ablest soldier, Forde, and a force which he could ill spare, and thus securing the cession of the Northern Circars and the transfer of predominance on the Deccan from French to English hands.

To return to Clive, who, after his victorious campaign, was in bad health and had need of rest. He married and returned to England in 1753. He was welcomed and feasted, and received a sword of honour from the Company, though he would only accept it if a similar distinction was conferred on Lawrence. He was elected to Parliament, but was unseated, and decided to return to India. He returned with a (King's not Company's) commission as Lieutenant-Colonel and the reversion to the Governorship of Madras in his pocket. On the way out he was deputed to destroy the piratical stronghold of Gheria, and this done he proceeded to Madras, and landed on 26th June, 1756, the day on which in Calcutta the tragedy of the Black Hole

had occurred. I need not dwell on a passage of history so well known. It suffices to say that the black hole was a small police cell in the Calcutta fort. Surajud Dowlah, the Nawab of Bengal, had for some fancied slights quarrelled with the chief of the Company's settlement at Calcutta, and marched an army down; and, after the fort had been hastily and discreditably evacuated by the Governor and by a portion of those who should have defended it, had succeeded in capturing it, and with it 146 prisoners. These 146 prisoners were thrust into the police cell, intended to contain two or three prisoners, in a night in June, the very hottest month of the year. Of the 146 who went in only 23 came out alive. To avenge this outrage and re-establish the Company's affairs in Bengal, the Madras Council despatched a force, the naval portion under the command of Admiral Watson and the military under that of Clive to the Hooghly, but it was not till the following January that they arrived. They very easily recaptured Calcutta, and, to show that they were in earnest, attacked and captured the Nawab's fort at Hooghly. This brought him down in wrath with an army of 40,000 men to Calcutta. Clive had taken up a position to the north of Calcutta, at Cossipore. The Nawab professed anxiety to negotiate, but, while preliminaries were going on, Clive found that the Nawab's army was marching round on his right flank into Calcutta, and that his camp followers were deserting, and his communications likely to be cut off. So he determined to attack, and did so before daybreak on the 4th February. He penetrated easily enough into the midst of the Nawab's camp, and then found himself enveloped in a thick fog. (Those of us who have been in Calcutta know how thick an early morning fog can be there in the cold weather.) In consequence there came about a want of cohesion in his force, and he was badly mauled, his own artillery firing into his leading lines. However, he got his men together, and brought them safely out of their difficulty; and the result was so to impress the Nawab that next day he withdrew his army, and entered into a treaty acceding all Clive and Watson had stipulated for, viz., the confirmation of all the Company's privileges, restoration and compensation for the plunder of Calcutta, to which was added, on Surajud Dowlah's initiative, a mutual offensive and defensive alliance. But another result was that the Nawab's mind was so upset that henceforth he fluctuated between hatred and fear of the English, so that all confidence in him on the part both of his own people and of the French, who might have helped him, was lost.

This was the turning point in Clive's career. After this he takes up the work of diplomatist and statesman, and his soldiership is subordinated thereto. In conjunction with Admiral Watson he captured Chandernagore, and, aided by the defection of Surajud Dowlah's generals, he won the battle of Plassey; but this battle was more important in its political than in its military aspect, and subsequent to it he never had occasion to meet an enemy on the field of battle. It is true that he "organised victory" over the French in the Northern Circars, and over the Dutch when they attacked him in Bengal; but in both cases the work, though planned by Clive, was executed by Forde. It is true also that he took the field against an enormous native force under the Emperor's son, who started to invade Bengal from the North, but on the appearance of his advanced guard at Patna, this force melted away and there was no more fighting—so I shall have but little more to say concerning his military career, except in regard to the "crowning mercy" of Plassey. What led to Plassey, was the character of Surajud Dowlah. We call him Surajud Dowlah, but his real title was apparently, Chiragh ud Doolah—the lamp of the State. Whatever his name, he was by all accounts, one of the meanest, most cowardly, most vacillating, cruel and treacherous rulers ever set on an Eastern throne, and I have formed my opinion of him not more from our own historians, than from the account given of him by the Mohammedan author of "Syar ul Matakherin," and from the description of his character in the exceedingly interesting "Memorandum" left by M. Law, a French officer, who knew him well, who served him, and was in constant communication with him, and would have helped him against the English had that been possible. Clive discerned early that the Nawab had no intention of keeping the treaty he had made, and that he was appealing to the French in the Deccan, as well as to native powers, to assist him to get rid of us. About the same time, Clive was made aware that the Nawab's own chiefs and generals were, out of sheer disgust at his character, planning to dethrone him; and being sounded, Clive and the Calcutta Council agreed to join, and aid the conspirators. "You cannot touch

pitch, and not be defiled," and an English gentleman certainly cannot join in an Oriental conspiracy without lowering his moral tone. This was Clive's case. He had to deceive and flatter the Nawab, and profess friendship for him, while matters were in progress, and this he did with the same coolness and audacity that he had always exhibited in action. More has been heard, and more serious attacks have been made on Clive in regard to his dealing with Omichund (Aminchund was his name, but, thanks to Macaulay, history will always know him as Omichund), and I fear the condemnation is sound. Omichund, a wealthy Hindoo banker, was one of the conspirators, and a go-between in the confidence of both parties. When the conditions were agreed on, and the terms about to be put in writing, Omichund threatened to disclose the whole plan to the Nawab, unless a clause was inserted in the agreement securing to him an unheard of sum of money, viz., a sixth part of the Nawab's jewels, estimated at $4\frac{1}{2}$ millions sterling, and, in addition, 5 per cent. on all the Nawab's treasure. If Omichund carried out his threat, it would mean not only the failure of the whole plan, but certain death to the British Agent, Mr. Watts, and to all the leading conspirators in the Nawab's power, and possibly, with French help, destruction to the settlement. It was determined, in Council, to trick Omichund by preparing two agreements, the real one without any such clause; the false one with the clause which Omichund demanded, the former to be shown to the conspirators generally, the latter only to Omichund. Admiral Watson objected to signing the false agreement; and as Omichund would surely have noticed the deficiency, Clive directed his secretary, Mr. Lushington, to affix the Admiral's name. To this Admiral Watson did not apparently demur, and the thing was carried through. Clive afterwards, when his conduct was being examined by a committee of the House of Commons, justified his action, and said that in similar circumstances he would do the same thing again. Among historians Malcolm alone defends him. All others, from Mill and Macaulay down to the latest biographer, condemn the act as not only a crime but a blunder. It must have been particularly distasteful to Clive, who at all other times and in all his dealings, with his equals and superiors, showed himself throughout his life to be a man of conspicuous straightforwardness and openness; but he certainly believed that in dealing with men like Omichund he was justified in meeting them with their own weapons, and when we condemn him let us remember that he had to choose between sacrificing either his own uprightness or the lives and fortunes of the numberless people dependant on his action. So the conspiracy was carried out, and Clive met the Nawab's forces at Plassey.

The field of Plassey, like many other place-names in Bengal, owes its designation to a conspicuous tree that once stood there. No one who knows the jungles of India in March and April (we do not speak of spring in a country which has no winter, and where the trees generally retain their leaves all the year round), no one I say can fail to be struck by the wealth of colour with which the jungle is enriched at this time of year by the trees and flowering shrubs. Conspicuous among these are the orange-coloured blossoms of the *butea frondosa*, called in Hindustan the dhák tree, in Bengal the palás. It was from one of these trees that Plassey derives its name. I have myself visited Plassey, and though the general outlines of the battlefield can be made out, the particular landmarks noted in all the contemporary accounts of the battle are for the most part gone. Gone is the mango tope in which Clive had his entrenchments; gone the small hunting-box at the corner; gone also the brick-kilns which were his advanced posts. The very loop of the river within which the Nawab's army was entrenched is discernible only as a depression in the ground. Only the tank held by St. Frais and his Frenchmen remains, together with the mound that dominated it. In a country where the action of the great rivers in the rainy season is so rapid that acres upon acres of solid ground are swept away in a single night and accretion takes place with almost equal rapidity, the disappearance of these land marks is not to be wondered at, but the general outline is still easily recognisable. A pillar to mark the ground was erected by my predecessor in office, Sir Rivers Thompson, and this is now to be replaced by a worthier monument under the auspices of Lord Curzon.

The battle of Plassey as a military exploit, as I have said, was not remarkable. Clive had in all 3,000 men of whom one-third only were Europeans. The Nawab had 50,000, of whom the cavalry were alone formidable, and of these 50,000 a large proportion were commanded by officers already in league with Clive. The battle began and continued for some time as an

artillery duel which was interrupted by a heavy storm of rain. This led to the Nawab's artillery drawing off to protect their ammunition, whereupon Clive emerged from his entrenchments, and Mir Madan, the Nawab's most faithful general, thinking that Clive's ammunition would also be spoilt by the rain, prepared to charge. His cavalry was driven off and he was killed. About the same time the division of Mir Jaffier, on Clive's right flank, was seen to separate itself from the rest of the Nawab's army leaving Clive's flank unthreatened. On this he advanced, and the only stand was made by the small detachment of Frenchmen under St. Frais, and on these being driven off the whole army fled, the Nawab having been the first to go. The rout was complete, but the losses were small, that of the victors less than 70, that of the vanquished between 500 and 600. But from and after that day the English became the real rulers of Bengal, and from the fact that they were the masters of Bengal, with access to the sea in one direction, and the great highway of the Ganges into the heart of Hindustan in the other, they were enabled, nay they were forced (for the most part unwillingly) to advance till they had absorbed the whole country. It has often been said that had Dupleix succeeded in his schemes, the French, after mastering the Carnatic and the Deccan, would similarly have absorbed the whole of India. I think this very doubtful. Without the command of the sea, and with wastes and mountains in front, instead of the easy highway through fertile districts, which the Ganges afforded to the owners of Bengal, the task would have been an infinitely more difficult and hazardous one than fell to the lot of the English.

But to return to Clive. His share of the prize, and the gifts of the new Nawab, made him an enormously wealthy man, and though, judging him by the rules and standards of that time, I think he was quite justified in accepting these gifts, the example was injurious; the wealth that poured in on the Company's servants in Calcutta led to an unhealthy competition to get rich, and, later on, when Clive had left Bengal, to unheard of tyranny and corruption. In this way, Clive's wealth was of baneful augury :—

Exemplo trahentis
Perniciem veniens in ævum.

Clive returned to England in 1760. At the early age of thirty-four he had given an Empire to England, he was in the zenith of his fame, and was one of the wealthiest subjects of the Crown, but he was yet to return once more to India, and in this last visit, of less than two years, he performed the hardest and noblest work of his life.

During the four years of Clive's absence in England, affairs in Bengal reached a stage of corruption, indiscipline, and incompetence, that threatened early and irretrievable ruin to the Company. There had been a series of revolutions, the occupant of the throne of Bengal having been changed three times in those four years, and on each occasion the new puppet had been forced to empty his treasury to satisfy the rapacity of the Governors and Council at Calcutta, and this not even under the pretence of benefiting the Company but for their own personal and private plunder. Worse than this, the right which the Company had been granted, of introducing their seaborne goods into the country, free of import duty, was interpreted as permitting all servants of the Company to carry on internal trade in the country, free from all transit and excise duties. These servants of the Company again transferred the right to their native subordinates, and thus a state of tyranny and license had been introduced which led to constant uprisings and a continual state of armed intervention, the expense of which threatened bankruptcy to the Company. In these circumstances, there was a universal call upon Clive to return to India. He undertook the task with the powers of Governor-General and permission to supersede the Council by a small committee of four of his own nominees. But he found it the most difficult job of his life. The army was almost as corrupt as, and even more out of hand, than the civil service, and he had to contend not only with corruption and indiscipline below, but with stupidity above. His masters, the Court of Directors, could not be brought to see that the principles on which they had conducted their own trading concerns were inadequate to the administration of an Empire. They could not be brought to understand that if their civil servants were to be incorrupt they must be adequately paid. The Court of Directors continued to insist on giving miserably inadequate salaries, but allowing these to be supplemented by private trade. Clive's reforms were, therefore, only partial and incomplete, but he did much. He dismissed sundry high officials and suspended others for corruption: he made all servants of the Company sign a covenant that they would not take bribes, nor even

receive presents from the natives of India. He supplemented their inadequate salaries by an arrangement under which the monopoly of salt was devoted to this purpose in certain fixed proportions: he stopped the usurped exemption from duty of the private internal trade, and he did all this in the teeth of the opposition of all those whose profits he restricted, with only the half-hearted help of his own committee, and with the assistance of a few of the Company's civil servants from Madras, whom he borrowed for the occasion.

As has been well said by one of Clive's biographers, after enumerating his reforms, and explaining their limitations—

"The want of intuition, of foresight, on the part of the Court of Directors rendered it impossible for him to do more. That ultimate aim was to come after him; his principles were to triumph; his harassing work had not been done in vain. It was by adopting in their entirety the principles of Lord Clive that the Civil Service in India became one of the noblest services the world has seen—pure in its honour, devoted in the performance of its duties, conspicuous for its integrity. . . . The work of a great man lives after him. There is not at this day a member of the Civil Service of India who does not realise that for him Clive did not live in vain."

With the military he had more difficulty. By introducing the organisation which I am about to mention he had laid the foundation of the Indian Army as it lasted for 100 years; but the organisation was new, and involved, of necessity, a certain amount of heart-burning. But the immediate difficulty was an order of the Court of Directors, withdrawing a money allowance that had been granted as a bonus by Mir Jaffier after Plassey, and had been continued till it had come to be looked on as a permanent right. This order, which Clive considered it his duty to enforce, brought the insubordination to a head. Two hundred officers agreed to throw up their commissions on the same day, while a Mahratta force was actually threatening the frontier, unless Clive yielded. Clive would not yield. He visited each brigade in turn, had the ringleaders arrested (trusting to the fidelity of the sepoys who stood by him), supplied the places of the recalcitrant officers with others borrowed from Madras, gave commissions even to civilians, and won the day. The officers submitted, the ring-leaders were cashiered, and the junior offenders forgiven. Nobly had Clive redeemed the vow to which, in writing to an intimate friend, he had given expression immediately on his return to India:—

"Alas," he says, "how is the English name sunk. I could not avoid paying the tribute of a few tears to the departed and lost fame of the English nation—irrevocably so I fear. However, I do declare by that Great Being, Who is the Searcher of all hearts, and to whom we must be accountable if there be a hereafter, that I am come out with a mind superior to all corruption, and that I am determined to destroy these great and growing evils, or perish in the attempt."

But in this war against corruption in high places, in thwarting the mad passion for immediate wealth, Clive made innumerable and bitter enemies, and their hostility later on was to render life a burden to him. He had one more task to perform, however, before ill-health compelled him to resign his great work as a reformer. This was to arrange with the Mogul Emperor and with the new Nawab for the Company, in consideration of paying him a sum of 53 lacs (about half a million) annually, to take over the *Diwani*, or collection and administration of the Revenues of Bengal.

Clive had early understood and urged on his masters that either we must wholly govern the Nawab, or the Nawab must wholly govern us, and this measure, while it reduced the Nawab's ostensible power to the shadow it had in reality become, had the inestimable advantage of putting an end to revolutions and intrigues, and compelled the Company to stand out as the real administrator of Bengal, and to recognise, if only slowly and gradually, its duties and responsibilities.

Of the rest of his life after his return to England I have little to say. The most notable event was the Parliamentary enquiry into his conduct, engineered by his enemies, with a view to his ruin. His ancient firmness and steadfastness did not desert him under this ordeal, and the result was not what his enemies desired. While condemning as a general principle, the system which had put it in Clive's power to accumulate his wealth, the Committee struck out the corollary making their condemnation applicable to Clive personally, and inserted on the other hand a clause affirming that Clive had rendered great and meritorious services to his country. The rest of Clive's life was one of depression and disappointment. He had all his life suffered from attacks of depression complicated with much physical suffering from an internal disorder. Quite early in his career he had attempted his life, when the pistol failed to go off, and on a

friend coming in and firing it without difficulty, Clive had said: "Then I am reserved for something great." On another occasion he had in consequence of one of these fits of depression, to be sent on a sea voyage with an attendant to watch him. His frequent attacks of pain (from gall stones) had led him to use opium as an anodyne, and the habit, with the disorder, grew on him. Ultimately, before he was 50 years old, he took his own life. A singular story is told in a footnote to Malleson's life of him, showing how Clive maintained his self-control to the end. As he passed through his drawing-room a lady staying at his house asked him to mend a pen for her: he took out his penknife and did so. He then went on into his own room and turned the knife upon himself.

I must leave you to draw the moral of Clive's life for yourselves. He was gifted with an unusual share of the qualities that make a man great. Courage, physical and moral, unconquerable firmness in face of difficulties, quickness to seize the weak and strong points of a situation, extraordinary readiness of resource, a Napoleonic capacity for acquiring the love and confidence of his soldiers; all these were his in abounding measure. Of his faults I need say little: in so far as they detract from his usefulness as an empire builder they have already been noticed, and they were amply redeemed by his later work.

Of Clive's victories most of us have heard. As statesman and administrator he is much less known, yet in this capacity not less than in that of soldier, he should rank as one of our greatest empire builders. He not only saved the Karnatic and acquired Bengal for England, thereby leading up as I have shown to the further extension and consolidation of the Indian Empire, he practically moulded the weapon with which he achieved his victories. He was the real founder of the Indian army. I have spoken of the steps he took to improve the drill and discipline of the sepahis. In his last visit to Bengal he divided the company's European forces into three regiments, and the native battalions he converted into an army by the great step of changing the officers' general list into regimental lists, that is attaching officers to the sepoy regiments throughout their whole career—a very far-seeing and statesmanlike move; he then organised these, together with the European regiments and the due proportion of cavalry and artillery, into three brigades commanded by general officers (without other commands), thus initiating the organisation which lasted almost unchanged for a century. I have shown what he did to purge the Civil Service of corruption, and how he urged on the court of directors the precept of adequate salaries and no perquisites, on which the full reform of that service was eventually achieved. The fulfilment after longer or shorter intervals of many other of Clive's recommendations show him to have been a wise and far-seeing statesman. He saw that the directors as a commercial body were unfit to govern India, and that their procedure was hopelessly inept. The recommendation he made to Chatham was that the Crown should take over the Government. Failing that, he recommended that two of the directors should be Crown nominees; that the directors should be appointed for a term of years instead of annually, and work in committees instead of in one unwieldy board. He recommended that there should be one Governor-General for all India, with headquarters in Bengal, assisted by a council of five, and with power to override them; instead of by a council with 16 all with equal votes. He wished the subordinate administration to be left entirely in the hands of the natives, but lawyers of repute to be sent out to remodel the courts of justice. In all these matters he pointed out the way to reforms which have since been wholly or in part proceeded with on the lines indicated, and in all his work, whether as soldier, as administrator, or as statesman, I feel justified in claiming for him such a share in the foundation of the Indian Empire as to merit the tardy recognition which Lord Curzon and others are endeavouring to secure for his memory at the hands of his countrymen. I say Lord Curzon and others because, since writing this address, I have heard from Lady Mary Herbert, of Styche, that another fund is being collected by her in order to place a local memorial of Clive at Moreton Say, the place of his birth and of his burial. There is room for both memorials, and to both I wish all possible success.

Before I sit down, I have a word to add as to the prospects of the coming Session. They are exceptionally good. Not only is there a very full list of papers for the ordinary and for the sectional meetings, but, besides the usual courses of Cantor lectures, there is a course to be given under the Howard Trust by Professor Hele Shaw, also a series of six lectures on "Industrial Hygiene," under the Shaw Trust; moreover, we are to have the new and excep-

tional honour of a lecture (to be called the Aldred Lecture), which will be delivered on the 11th December by Sir William Ramsay.

After delivering the Address, the Chairman presented the Society's medals which were awarded for papers read during last Session.

At the Ordinary Meetings :—

To Mr. John William Gordon, for his paper on "Patent Law Reform."

To Colonel Sir Charles M. Watson, K.C.M.G., C.B., for his paper on "Some Objections to the Compulsory Introduction of the Metric System."

To Mr. Albert E. Humphries, for his paper on "Modern Developments of Flour-Milling."

To M. Philippe Bunau-Varilla, for his paper on "The Panama Canal—the 'Lock Canal' type and the 'Straits of Panama' type."

To Mr. Arthur E. Morton, for his paper on "Modern Type-writers and Accessories."

To Mr. Noel Heaton, B.Sc., for his paper on "Mediæval Stained Glass, its Production and Decay."

To Mr. Herbert Wright, for his paper on "Rubber Cultivation in the British Empire."

To Mr. Alfred Edward Carey, M.Inst.C.E., for his paper on "The Protection of Sea Shores from Erosion."

In the Indian Section :—

To Mr. A. Yusuf-Ali, M.A., LL.M., I.C.S., for his paper on "The Indian Mohammedans: their Past, Present, and Future."

To Major E. Barnes, for his paper on "The Bhils of Western India."

To Sir Frederic S. P. Lely, K.C.I.E., C.S.I., for his paper on "The Practical Side of Famine in India."

To Mr. Laurence Robertson, I.C.S., for his paper on "Irrigation Colonies in India."

In the Colonial Section :—

To Mr. George Wilson, C.B., for his paper on "The Progress of the Uganda Protectorate."

To Hon. John Winthrop Hackett, LL.D., for his paper on "Social and Economic Conditions in Australia."

In the Applied Art Section :—

To Mr. Thomas Okey, for his paper on "Basket Making."

To Mr. William Dale, F.S.A., for his paper on "Artistic Treatment of the Exterior of the Pianoforte."

Sir Owen Roberts, in proposing a hearty vote of thanks to the Chairman for his interesting address, said that the Society had been singularly fortunate in having on its Council year by year recruits distinguished for their services to the Indian Empire. The audience had listened with great pleasure, a pleasure which he thought had seldom been equalled in any address he had heard at the Society, to the romantic history of the foundation of the Indian Empire. The delivery of the address was graced by a diction seldom surpassed in the hall, although addresses had been delivered in it by some of the most distinguished men, literary and scientific, whose names had adorned the annals of England. Sir Steuart had done his valuable work and spent his life in India, and had brought back and retailed to the audience the story of Clive. He thought it was very apposite that that story should be told during the year when the 150th anniversary of the victory of Plassey was being celebrated; and he hoped it would have the effect of stimulating English people to erect an adequate memorial to Clive, for no memorial could be too great as a return for the services which he rendered to this country. The Indian Empire had been the nursery of commerce, trade, and manufactures of many kinds, to this country, and the Society was very grateful indeed to the Chairman for having brought before it a picture of an important episode in its history, with such charming diction and grace.

Sir William Bousfield, in seconding the motion, said that no one could have listened to the address without feeling stirred as an Englishman at the work which a great Englishman did 150 years ago. He thought the Society was greatly indebted to the Chairman for putting so clearly in a wonderful address the story of Clive's life. One could not help feeling that Sir Steuart had that advantage of the family connection with Clive which brought a reality to his view of Clive's life, and which had enabled him to refer to private letters, and to the views of those who looked at Clive as a boy and as a man in a way which would otherwise have been impossible.

The resolution was put and carried unanimously, and the Chairman having briefly acknowledged the compliment, the meeting terminated.

ITALIAN COMMERCIAL SCHOOLS.

The graduates of the Royal Commercial School of Venice, and similar schools established in the principal commercial countries of Europe, supported in part by the respective Governments, constitute the class from which European manufacturers select to represent them in promoting trade in foreign markets. The founding of the Royal Commercial School of Venice, may be said to date from the signing of the royal degree of approval on August 6, 1868, and was the direct result of the commercial awakening which marked the incorporation of the Venetian provinces

into the kingdom of Italy. Modelled after a school already existing at Antwerp, it was organised with a governing board composed of delegates from the Provincial Council, the Communal Council, and the Chamber of Commerce, three elective bodies which, with the Italian Government, had combined to establish it. This board was later increased by two delegates from the Italian Government. The school, according to the American Consul at Venice, is supported by subsidies from the Province of Venice to the extent of £1,600; from the Italian Government, £1,000; the city of Venice, £400; and from the Chamber of Commerce £200. In addition there are the tuition fees, &c., amounting to about £1,000, which brings the total up to £4,200. This sum, while sufficient for the running expenses of the school, does not permit of that enlargement and improvement which is desired, and it has been stated that the subsidy of the Government will be increased. The number of students in the school is only 186, and this small attendance probably depends, first, upon the lack of scholarships, and, secondly, upon the fact that the average young man able to pay for his education, and desiring to prepare himself for the public service or for commercial life, prefers the freedom of the universities, where registration is all that is required to enable a man to present himself for examination, and where attendance at lectures, &c., is not compulsory as in the commercial school. In justice to the Italian universities, it must be noted that the laxity above referred to is, says the American Consul, only allowed in the course resulting in the *laurea i giurisprudenza*. The courses of study which are offered are three in number—the commercial, of three years; the normal, of four and five years; and the consular, of five years. In the first year the subjects studied by the commercial and consular classes are identical, and consist in Italian literature and language, French, German, and English, economic geography, algebra, commercial institutions, civil law institutions, and caligraphy; while the normal class has an exhaustive training in the Italian language and literature and foreign languages. In the second year the commercial class continues the subjects of the first year, less the study of commercial institutions, but adding mercantile calculation, commercial and maritime law, and the practice of commerce, &c. The consular class has the same subjects of study as the commercial, minus the practice of commerce and plus civil law. The normal class in this year is divided into four sections, depending upon the branches for which its members are preparing themselves, viz., legal, economic, and statistical subjects, commercial science, and foreign languages. In the third year the commercial class graduates, after continuing the studies of the preceding year, less the course in commercial institutions and with the addition of commercial law, the history of commerce and political economy. The consular class adds the same subjects to the curriculum of the second year, while the normal classes continue in their respective branches. The fourth year shows a programme for the consular class of the three foreign languages, political history, and the history of diplomacy, international, civil and constitutional law, criminal law and procedure, political economy, finance and statistics. The consular class in the fifth year adds a course in civil procedure to those of the fourth year. After such a course of study as is required by this school, it is not surprising that its graduates have little difficulty in finding employment, or in securing positions in the Government service, which, from the schoolmastership to the diplomatic and consular service, are only to be obtained after the most stringent competitive examinations. It is said that graduates in the commercial class are eminently fitted for the work before them, and by promoting trade and industry become a positive asset to the community and to the nation, while those who have succeeded in passing the final examinations are wonderfully equipped. In fact, the work accomplished at Venice and in the similar though smaller schools of Bari and Genoa has led to the project being formed of establishing two more institutions on the same lines, one in Turin and the other in Rome. These, being in larger places, will be numerically and financially more prosperous, but as to standard it will be most difficult to improve on that of the school in Venice.

RAILWAY DEVELOPMENT IN GERMANY.

In his report on the trade of Bavaria for 1906 and the earlier part of the present year (Cd. 3727-19), Mr. Consul Buchanan refers to the electrification of the railways in the Bavarian uplands, which means a yearly average saving of 16s. to 19s. per horse-power to start with, and from £2 17s. to £5 9s. when the traffic has increased by 50 per cent., which may be in 15 or 20 years from the time of introducing the electric power. The trunk line from Munich to Ludain, 137 miles long, and all the lines north of it, will be the first to be electrified. For that purpose 92,000 horse-power will be necessary, and in this particular case the annual average economy would amount to £3 15s. per horse-power, or about £345,000 in all. A Dresden engineer has submitted a project of railway to the summit of Zugspitze, the highest mountain in Germany (9,711 feet), situated on Bavarian territory. This project, which Mr. Consul Buchanan says has every chance of being realised through private enterprise, the preliminary concession having been granted by the Bavarian Government, provides for an ordinary railway seven miles long, starting at Garmisch (2,364 feet), and for a cable line from Eibsee (3,146 feet), $2\frac{1}{4}$ miles long, to the summit of Zugspitze. This line, with a total length of $9\frac{1}{2}$ miles and three tunnels, would have an average gradient of 6 per cent.; the cost of its construction amounting to about £2,000,000. The journey, according to the project, would be accom-

plished in an hour and a-half, and the return fare amount to 12s. 6d. The Bavarian Government have granted a concession to a Swiss engineering company to construct a mountain railway from Schliersee to the Wendelstein (6,028 feet) in the Bavarian highlands. A practically new system of railway signalling throughout the German Empire has now come into use, and some of the regulations hitherto only used in Bavaria have been incorporated in the new system. The growth in the railway passenger traffic of Germany may be gathered from the fact that whilst 10 years ago 11 railway tickets were sold on an average per head of population, 19 tickets are sold now. During the same period the German railway system has increased by 6,250 miles, so that at the beginning of the present year Germany possessed 34,375 miles of railway lines, and the annual receipts from passenger traffic had increased from £21,500,000 to £33,250,000. The number of railway officials increased in the same ten years by over 40 per cent., and amounts now to 606,212 persons, so that for every 99 inhabitants in Germany there is one railway official.

OSTRICH FARMING IN CUBA.

An experiment in ostrich farming has recently been started at Marianao near Habana. The farm contains about twenty-seven acres, with shelters for the birds in inclement weather and a house for the employés. The land is divided into large pens for the younger birds, and smaller ones for each pair of breeders. There is also a salesroom, where ostrich feathers are sold, not however, necessarily the product of the farm, According to the American Minister in Cuba, there are at present forty-eight ostriches at this farm. twenty-three of which were imported from an ostrich farm at Phœnix, Arizona, and the balance from France. Fourteen of these are breeders and the others are between one and two years old. The price of the full-grown breeder is from £60 to £80, and that of the younger birds from £50 to £60, according to their age and sex. The cost of importation from either Arizona or France is about £3 10s., if imported in quantities of twenty or more, including customs duties. The ostrich lays four times a year, each female laying from fourteen to eighteen eggs at each laying. About twenty per cent. of these hatch out, and about seventy-five per cent. arrive at maturity. The period of incubation is about forty-two days. The young birds are kept in pastures near the house, and at night are put in artificially heated houses. At the age of six months they are placed in larger fields, but must be housed in inclement weather until they arrive at the age of twenty months. They are fed on a mixture of bran, indian corn oats, barley and alfalfa, all of which are imported from the United States. The first plucking is done at the age of six months, when the feathers are narrow, coarse and of small market value. Thereafter they are plucked every eight months, the feathers increasing at each plucking until they arrive at the age of four years. When ready to be plucked, the bird is placed in a V-shaped corral, large enough to contain his body and that of the plucker. His wings are then raised and all the ripe feathers are clipped. Two months later the quills left in the wings are entirely dead, and are drawn without pain to the bird. The raw feathers are then sent to New York and sold to the dealers, who prepare them for the market. The yield of an adult male bird in raw feathers is about £12, and that of the female bird about £9. The price at which they are sold is regulated by the London market. There are two varieties of ostrich, the Nubian and the South African. The feathers of the former are larger and of finer texture than those of the latter, but they have not the same thickness and width. An attempt is being made to cross the two breeds with the object of combining the length and texture of the Nubian feather with the width and thickness of the South African.

ADMIRALTY CHARTS.

The following is the official list of charts issued by the Hydrographic Department, Admiralty, in September, 1907 :—

New Charts. — No. 3644 — Sweden, west coast :—Gullmar and Stig fiords, inclnding the fiords and channels leading to Uddevalla. 3645 — Ports on the west coast of France: —Baie de la Forest and port Concarneau, port de Loctudy, port de Benodet. 914—Ceylon, west coast: — Colombo harbour. 127 — Japan, north coast :—Hirado Kaikyo to Shimonoseki Kaikyo. Plans :—Kurato seto and Ashiya ura ; Ainoshima anchorage.

Charts that have received additions or corrections too large to be conveniently inserted by hand, and in most cases other than those referred to in the Admiralty Notices to Mariners :—

No. 1095—England, south coast:—Southampton water. 120—North sea :—River Schelde from the sea to Antwerp. 3506—North sea :—Aussen Jade and Schillig road. 126—North sea :—Heligoland. 2329—Norway, sheet III. :—Sandöen to the Svenöer. 2330—Norway, sheet IV. :—Christiana fiord. 1974—Norway :—Jælöen to Rauö, including Sigle and Ide fiords. 284*b*—Baltic sea. 1053—Spain, west coast: —Cape Peñas to Pontevedra bay. 1755—Spain, west coast :—San Ciprian bay to cape Finisterre. 541—South America, east coast:—Rio de Janeiro harbour. 575—Bay of Bengal: Madras to Ramiapatam. 1419—Bay of Bengal, Andaman islands :—Long island to port Blair. 1705—Australia, north-west coast : —Victoria river.

These charts are published by Mr. J. D. Potter, 145, Minories.

ARTS AND CRAFTS.

The Silver Altar for St. Mark's, Philadelphia.—The Silver Altar for the Lady Chapel at St. Mark's, Philadelphia, produced by Messrs. Barkentin and Krall, of Regent-street, under the supervision of Mr. Krall, has lately been on view in London. It is probably the most important piece of silversmith's work executed in England within recent years—as elaborate in its way as the celebrated altar at Florence, though, of course, not by any means so large. The central feature of the design is a figure of the Madonna standing under a simple canopy and holding the Child in her arms. On each side of her are six panels, arranged in two tiers, depicting the various scenes from the life of the Virgin, and these panels are divided vertically by half-columns, enshrining each eighteen little figures of saints in full relief, each one under a separate canopy. Every capital contains a group of three kneeling angels, and between the capitals and connecting them, runs a rich band of scrollwork in deep relief. The horizontal division of the panels is less marked than the vertical, and consists only of a line of roses with jewelled centres; whilst similar bands of ornamentation divide the subjects from the cornice and the plinth. The fact that the complete work comprises some hundreds of figures (there are a hundred and forty-four on the half-columns alone) gives some idea of the complexity and detail of the design; and it will be readily understood that so important and so intricate a piece of work has necessitated great labour and great care in production, and has taken the best efforts of skilled craftsmen to carry to a successful conclusion. It is not often that an elaborate piece of silversmiths' work on a scale in any degree approaching that of the altar for St. Mark's is wanted. Monumental works in silver are naturally rare; it is satisfactory to find that when America wants such a noble piece of work she comes to England for it. It is further gratifying to know that, however divergent may be the opinions with regard to the design of the altar, however differently people may regard the employment of such multitudinous figures, however much they may cavil at this detail or that, we are at least sending to America a piece of workmanship of which we have no cause to be ashamed and every reason to be proud.

Design.—At this time of year signs of change in design, for new patterns in anticipation of the new year, are looked for. Things move so quickly now-a-days that some change sufficiently important to be worth chronicling may be expected to take place in the course of six months or so, and as a rule the expectation is not in vain, since it is manifestly to the interest of the producers to have some new thing to show; not, of course, some violent change, but some notable progress in the fashion of design. It is not so very long ago that *l'art nouveau* was the rage—and now, perhaps, in large measure because it was taken up with such energy, it has been slowly dying for some time past. One of the distinguishing facts about this season may be said to be its death. It can now no longer be seriously contended that *l'art nouveau* counts at all. Not only is it not the style of the future (so far as it is possible to predict what that will or will not be) but it is already old-fashioned, to all intents and purposes a thing of the past to be found only in the windows of shops with no pretentions to be more than second or third-rate. Oddly enough, the styles which have been slowly ousting it are the Early and Mid-Victorian—phases of taste themselves long since supposed to be defunct, and perhaps only resuscitated because of their utter unlikeness to the style that had gone before. However that may be, and whether we like it or not, these Victorian styles have slowly but surely edged themselves to the front again. We have for some time now been rejoicing in, or suffering from, hangings and covers decked with bunches of heavy full-blown roses and such-like—and this type ef pattern is yet with us. It may even be considered the prevailing style—but a little observation shows that, though it remains *en evidence*, its popularity has begun to wane. Fashion seems to be retracing her steps in the very footmarks which she had trodden before, and the Mid-Victorian designs are giving place to those which are in a certain degree, at least, reminiscent of the productions of William Morris—patterns which, when all is said and done, are really thought out and considered designs, not mere bits of semi-naturalistic detail thoughtlessly scattered over a surface. How history repeats itself!

Minor Exhibitions.—It is almost impossible when the numerous shows held in London and elsewhere which go by the names of "Arts and Crafts," "Home Arts and Industries," "Artists at Work," "Handicrafts and Home Industries," and similar titles, are considered, to realise that when the first Arts and Crafts Exhibition was held in London in 1888 people seriously went to the New Gallery and asked "where are the pictures?" We have certainly got very far away from the idea that all "art exhibitions" must consist mainly of pictures, and have gone almost to the other extreme of dignifying the most ordinary handicraft and sometimes even the merest fancywork with the name of art. The approach of Christmas is always the signal for a whole series of little exhibitions of objects of art which their makers believe, or at any rate hope, to be suitable for Christmas presents. These little shows are of various kinds, good, bad, and indifferent, and are almost entirely composed of rather small pieces of work. Some of them include almost every conceivable kind of "art work" and others are "one man shows," or are made up of the works of just two or three artists or craftsmen in the same, or more often different, crafts. The dates of these little exhibitions have been getting gradually earlier for

some years past, and this year they really began before October was out. Of one at least of those which have already taken place the less said the better; for, though held at a well-known gallery in the centre of London, it might easily have been mistaken by the unprejudiced observer who had strayed into it for an ordinary bazaar. There were, doubtless, some good things somewhere about, but it was quite impossible to see them.

The Sir John Cass Arts and Crafts Society.—An altogether more serious and more dignified little exhibition was held at Rowley's Gallery early in November by the Sir John Cass Arts and Crafts Society. The Sir John Cass Institute has for some time been one of the more important London art schools from a metal-working point of view, and the Sir John Cass Arts and Crafts Society is made up of past and present pupils of the school, supported, it would appear, by some of the masters at the school and a few outsiders, who were perhaps once pupils there. They held their first exhibition, which attracted some attention, last year. The exhibits this year included a few sketches, an heraldic panel in plaster, some statuettes (some of them very nice in feeling), and some other objects, not in metal, but it was in the metalwork, and especially the jewellery, that the main interest of the show centred. The brass and copper work is mostly the work of one exhibitor, and the simple candlesticks and other objects were some of them very satisfactory, with no unnecessary ornamentation, and fit both for their material and their purpose. In the one or two cases, however, in which the ornament was super-added to the object, and did not, as it were, grow directly from its construction-lines, the effect was not quite so pleasing. It did not look as though the ornamentation had been quite so carefully considered as the rest of the work. Again, it seems rather a pity to make a tea caddy with a domed top. The simple sandwich boxes, on the other hand, were pre-eminently practical. There was a good show of jewellery, mostly, it is to be noticed, by ladies. The most interesting work was that by Mr. Harold Stabler; but the exhibits on the whole were worthy of notice, though not perhaps so much from the point of view of workmanship as from that of design. The different members' work, of course, in different styles—though, coming as they do from the same school, it is not always quite easy to differentiate their handiwork. The exhibitors generally show a distinct feeling for colour, no matter whether this is represented by enamel or by precious stones, and there is a restraint about most of the work which distinguishes it from a good deal of the modern jewellery. The objects, mainly pendants, chains, and buttons, are not for the most part executed in *repoussé* or in chased work, but are built up of fine lines of metal which enclose or form the setting to, stones, not perhaps very precious in themselves, but chosen for their colour.

CORRESPONDENCE.

ORANGE GROWING IN NEW SOUTH WALES.

The recent shipment of oranges to England has called attention to the existence and possibilities of this Australian industry. The rate of prices obtained did not in this instance give a profit to the consignors however. It is hoped that the carriage of the fruit in good order being demonstrated costs may in future be reduced. In the coastal district of New South Wales orange growing is an extensive industry, but at present the markets are limited to Australia and New Zealand, so that its expansion is impossible. Cultivation is thorough in successful plantations, the ground being dug or ploughed in the winter and stirred during the summer by harrows, both drag and disc, cultivators, and hoes. Irrigation is not common, owing to the usually sufficient rainfall and the scarcity of permanent water. Bonedust from the meat-preserving works of the State is the principal fertiliser. Potash manures, superphosphate, sulphate of ammonia and other prepared manures are used to an increasing extent, the soil being as a rule shallow and inclined to poverty. Where available, forest scrapings of leaves and other vegetable matter are found a sufficient dressing to the orchards. The suitability of the climate for orange growing is shown by the age of some of the elder plantations. In the early days of settlement the tree was introduced from the Azores, and specimens exist of great size and productiveness in the Parramatta district.

Many varieties are now cultivated, of which the more promising are the Bahia or novel and the Valencia late; it is hoped to find a market for the latter in American ports owing to its season of ripening. The shipping facilities of Sydney are an encouragement to the production of export varieties. The Government of New South Wales is endeavouring to encourage the industry by experiments on the Government farms and the employment of experts as travelling lecturers and demonstrators in pruning, budding, grafting, and other subjects connected with fruit-growing. Local agricultural and horticultural societies are also subsidised and the railway freights on fruit of all sorts are so low as make the traffic barely profitable to the State railways; empty fruit packages being in fact carried absolutely free from one end of the State to the other. Fruit-growing is an industry of increasing importance in Sydney, and markets for jams of various sorts have been found in South Africa and the Far East. In this connection the sweet orange is not largely concerned, but large quantities of Sevilles are consumed for marmalade, and a small proportion of the rougher and cheaper sweet varieties.

J. S. HERON.

Pennant Hills, N.S.W.

OBITUARY.

Right Hon. Evelyn Ashley.—Mr. Ashley, who was elected a member of the Society of Arts in 1897, died on Friday morning, 15th inst., at his residence, Broadlands, Romsey, Hants. Anthony Evelyn Melbourne Ashley was the fourth son of the seventh Earl of Shaftesbury, the statesman and philanthropist, and was born on July 24th, 1836. He was educated at Harrow and Trinity College, Cambridge. From 1858 to 1865 he acted as private secretary to Lord Palmerston, the memoirs of whose life he afterwards wrote. On the death of his uncle, Lord Mount-Temple, he succeeded to the estates of the Palmerston - Temples, both in England and in Ireland. He was Parliamentary Secretary to the Board of Trade 1880-82, Under-Secretary of State for the Colonies 1882-5, M.P. for Poole 1874-80 and Isle of Wight 1880-85.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Conrad Beck, F.R.M.S., "The Theory of the Microscope." Four Lectures.

Lecture I.—November 25.—*The Microscope constructed from Uncorrected Lenses.*—Image formation by a lens—Simple microscopes—Three forms—Investigation by Gauss system of their defects and their cure, by separated lenses—Working distance increased—High power and large field obtained—Eye-pieces—Positive v. Negative—Ramsden circle—Magnifying power—Compound microscope.

Lecture II—December 2.—*The Correction of Simple Lenses.*—Bad quality of images formed by simple lenses—Chromatic correction—Apochromatic correction—Spherical aberration—Zonal aberration—Sine condition and Gauss surfaces—Tangent condition—Equal chromatic magnification—Summary of corrections—Correction of eye-piece.

Lecture III.—December 9.—*Influence of Diffraction.*—Explanation of diffraction—Slit—Convergent cone—Diffraction pattern or antipoint—Its influence on telescopic images—Its size—Abbé theory—Gordon's attack on Abbé theory—Relation of aperture to magnifying power—Oil immersion—Shape of and methods of reduction of size of antipoint—Limits of resolution and visibility—Special cases—Diffraction of the eye.

Lecture IV.—December 16.—*Applications of Theory.*—Best combination of eye-piece and object-glass—High power illumination – Gordon's oscillating screen—Useless aperture—Penetration for visual and photographic work—Effect of cover-glass—Substage condensers—Achromatism and aplanatism in condensers—Angle of illuminating cone—Illuminants—Monochromatic light—Wright's experiments—Critical illumination—Possible advances.

The Lectures will be illustrated by Lantern slides and Experiments.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Conrad Beck, "The Theory of the Microscope." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Sabin will re-open Discussion on paper by Mr. Aubrey J. Spencer, "The Agricultural Holdings Act, 1906."

Geographical, University of London, Burlington-gardens, W., $8\frac{1}{2}$ p.m. Dr. W. Hunter Workman, "The Exploration of the Nun-Kun Mountain and its Glaciers."

Actuaries, Staples-inn-hall, Holborn, W.C., 5 p.m.

Medical, 11, Chandos-street, W., $8\frac{1}{2}$ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. B. Stereni, "The People, Army, and Resources of Russia."

Tuesday, Nov. 26...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. S. H. Ellis, "The Tranmere Bay Development Works."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. F. Martin Duncan, "Photo-micrography."

Zoological, 3, Hanover-square, W., $8\frac{1}{2}$ p.m.

Horticultural, Vincent-square, Westminster, S.W., 3 p.m.

Wednesday, Nov. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. The Hon. Sir John A. Cockburn, "The Franco - British Exhibition, 1908."

United Service Institute, Whitehall, S.W., 3 p.m. Rev. Canon Edgar Sheppard, "Whitehall Palace and the Execution of King Charles I."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Mr. E. H. Pember, "Some Verdicts of Dante in the 'Inferno.'"

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

Thursday, Nov. 28...Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m.

London Institute, Finsbury-circus, E.C., 6 p.m. Principal Henry Hills, "The Literature of Youth."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Dr. Robert Pohl, "The Development of Turbo-Generators."

Friday, Nov. 29 ... SOCIETY OF ARTS, John street, Adelphi, W.C., 8 p.m. (Shaw Lectures on Industrial Hygiene.) Dr. John Scott Haldane, "The Hygiene of Work in Compressed Air (Diving, Caisson Work, Sub-aqueous Tunnelling, &c)."

African Society, Criterion Restaurant, Piccadilly, W., 8 p.m. Presidential Address by the Earl of Onslow.

Journal of the Society of Arts.

No. 2,871. VOL. LVI.

FRIDAY, NOVEMBER 29, 1907.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 2, 8 p.m. (Cantor Lecture.) CONRAD BECK, "The Theory of the Microscope." (Lecture II.)

WEDNESDAY, DECEMBER 4, 8 p.m. (Ordinary Meeting.) Sir EDWARD W. BRABROOK, C.B., "Old Age Pensions."

Further details of the Society's Meetings will be found at the end of this number.

CANTOR LECTURES ON THE MICROSCOPE.

On Monday evening, 25th inst., Mr. CONRAD BECK, F.R.M.S., delivered the first lecture of his course on "The Theory of the Microscope."

The lectures will be published in the *Journal* during the Christmas recess.

CANTOR LECTURES.

Professor John Walter Gregory's Lectures on "Gold Mining and Gold Production;" and Professor Herbert Jackson's Lectures on "Detergents and Bleaching Agents used in Laundry Work" have been reprinted from the *Journal*, and the pamphlets (price one shilling each) can be obtained on application to the Secretary, Society of Arts, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately, and are still on sale, can be obtained on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 27th, 1907; The RIGHT HON. VISCOUNT SELBY, LL.D., D.C.L., in the chair.

The following candidates were proposed for election as members of the Society:—

Coode, Arthur Treveneu, B.A., 45, Abingdon-villas, Kensington, W.
Foster, Vivian Le Neve, M.A., Eton College, Windsor.
Gaskell, Mrs. Ada E., Woolverton, St. Lawrence, Isle of Wright, and 98, Portland-place, W.
Haviland, Henry A., M.B., Magila, Tanga, German East Africa.
Johnston, William Caley, P.O. Box 44, Bocas del Toro, Republic of Panama.
Simonis, Henry, LL.D., Norfolk-house, Norfolk-street, Strand, W.C.
Vale, William, Tower-house, South Norwood, S.E.

The paper read was—

THE FRANCO-BRITISH EXHIBITION.

By THE HON. SIR JOHN A. COCKBURN, K.C.M.G.

Modern exhibitions may be regarded as the stock-taking of the resources of civilisation; they present a periodical summing up of the achievements of a progressive age, and mark, as it were, the mile-stones, by which we may judge of the advance made in Science, Art and Industry. From the universal adoption of exhibitions, as a means of thus punctuating our progress, they may be regarded as an essential feature of the age in which we live. It was in France that the exhibition idea originated. An exhibition was held in that country in 1798, and the tenth National Exhibition took place in Paris in 1849. The success which attended this, and the intervening displays, stimulated a desire for a similar exhibition in London.

The Society of Arts had long advocated industrial exhibitions in England, and had actually held them in the Adelphi in 1847, and following years. In 1849 His Royal Highness the Prince Consort — who was then President of the Society — took the matter in hand, with the well-known result that the world's first international exhibition was held in London in 1851. It was within these walls, therefore, that the idea of the international exhibition was conceived, and the Society of Arts may accordingly be termed the parent of international exhibitions.

Since 1851 the world has witnessed many exhibitions of an international character which rival one another in laying palace to palace and land to land until the mind becomes bewildered and reels at the magnitude of the vast prospect presented to it; and, from the very immensity of the scheme, fails to derive those advantages which a more limited display would afford. In the case of the Franco-British Exhibition, this perplexing profusion will be avoided; it will not overtax the powers of assimilation of the ordinary visitor. It seems probable that in many of the exhibitions of the future the international element will be dual rather than plural in its application, and what could be more fitting than that the two great nations, joint pioneers of the exhibition era, should set an example in this respect and should join hands in happy union for the purpose of setting before the world their combined resources.

France and Great Britain possess distinguishing characteristics which admirably blend together. Each abounds in those qualities which form the complement of the other. British solidity, adorned with French grace, yields a result that no other combination of nations can approach. In the history of the world, the greatest achievements in the art of civilisation have been the product of two races, just as the finest flowers are obtained by hybridization. It was through the mingling of the Pelasgian and Aryan races that Greece produced those masterpieces of plastic art which form at once the delight and despair of the modern world. It was to this combination that the classic orders of architecture, which found their consummation in Athens at the time of Pericles, owed their birth. The other great school of architecture, the Gothic, which attained perfection in England during the reigns of the Edwards in the fourteenth century, derived its sublime inspiration from the genius and fire of the Celt impinging upon the matter-of-fact and business-like habits of the Anglo-Saxon. It may be confidently anticipated that the world will be blessed with a propitious fruition when the ample achievements of the Anglo-Saxon and Latin races intertwine and reinforce each other.

In the Franco-British Exhibition not only France and the United Kingdom will be engaged, but the Colonial possessions of these two great powers will play an important part. Here, again, we have a significant conjunction. France, in addition to being a great colonising empire at the present day, can boast of a record in colonisation second to that of no other nation. The success of the French colonies in Africa, Indo-China, and elsewhere recalls the former achievements of France in Canada and India. In no country do the theory and practice of colonisation receive more careful and systematic attention than in France. Two colonial conferences were held in Paris during the Exhibition of 1900, and it is from French authors that some of the most interesting and instructive descriptions even of the British colonies emanate. The French colonies, dependencies and spheres of influence, second in number only to those of Great Britain, have an area of over 4,000,000 square miles and a population of about 60,000,000.

A wide difference exists between the methods of colonisation of the two great powers—Great Britain tending toward empirical, and France towards systematic and scientific measures, so that an interesting comparison may be drawn between them. Success in colonisation is sometimes determined by a faculty of assimilation to the customs of the countries colonised, and sometimes by the power of enforcing novel usages on the aboriginal inhabitants. Nations vary in their capacity in these two directions, but it may be confidently affirmed of France that she has a genius for both; for example, it is related that de Fontenac, for the purpose of recommending his administration to the American Indians in the West, went so far as to take part in their mysterious rites; while, on the other hand, Dupleix in the East Indies succeeded in superimposing on the population the system of European military discipline.

It is instructive in passing to compare the Colonial Empire of Great Britain, as existing at the time of the International Exhibition, 1851, with His Majesty's possessions of the present time. India was then under the Government of a chartered company. Canada consisted merely of Ontario and Quebec;

Nova Scotia and New Brunswick sending independent exhibits. Tasmania was officially described as Van Diemen's Land. It is interesting also to note that the illustrious Colonial Statesman and empire builder, Lord Elgin—father of the present Secretary of State for the Colonies—was at that time Governor-General of Canada.

But it is not only on the grounds above stated that the apposition of France and Great Britain in the friendly arena of an exhibition is to be welcomed. The history of the two races, has, for nearly a thousand years, been closely intertwined. It is in Normandy that we find the home of our Plantagenet kings; the tomb of Richard the Lion-hearted is to be seen in the abbey of Fontevrault. Our language is saturated with words of French origin, and the monarch of the British empire still gives or withholds his royal assent to the Acts of the British Legislature in the French tongue. Repeated interchanges of visits between Edward the Peacemaker and the President of the French Republic have taken place. What more natural, therefore, than that the King should write from Paris to "wish the Exhibition every success, and sincerely hope that it may be the means of strengthening the friendship which so happily exists between the two countries," or that M. Fallières should state in a message to the Lord Mayor of London that the French Government would not fail to give its cordial support to the Exhibition.

As most of you are aware, a site of 140 acres has been secured for the Exhibition at Shepherd's-bush. The principal entrance will be immediately adjoining the station of the Central London Railway (popularly known as "The Tube"), and within four miles of Charing-cross. It is also close to the Uxbridge-road Station of the West London and North-Western and Great Western railways, and Metropolitan, Hammersmith and City Railway stations. It is in close proximity to the Shepherds Bush station of the London and South-Western Railway, and in direct connection with the District, North London, Metropolitan, London, Brighton and South Coast, South - Eastern and Chatham, and Great Central Railways. It is, moreover, at the centre of a network of tramways and omnibuses affording means of communication with all parts of London and the suburbs. The various methods of transport are capable of conveying to the spot 75,000 persons per hour, or nearly a million visitors during the hours per diem in which an exhibition is usually kept open.

On the ground adjoining the Exhibition the quadrennial Olympic games are to be held. This also is an auspicious conjunction, for it was at the instance of France that this great festival of Ancient Greece was revived in Athens in 1896. The Olympiad was celebrated in Paris in 1900, and in St. Louis in 1904; generations will pass away before it is again held in England, and as at least twenty-two nations are taking part in the contests, the occasion will be unique in the annals of British sports. To accommodate the vast concourse of spectators, there is in course of erection a colossal stadium, oval in form, and capable of comfortably seating 68,000, and on occasion, of holding 150,000 people. Some idea of the vast proportions of this theatre may be gathered from the fact that it encloses a cycle-track with $2\frac{3}{4}$ laps to the mile, and a running track of $\frac{1}{3}$ mile in circumference. There is in the arena of the stadium a tank 240 feet in length and 14 feet in depth for the swimming and high diving competitions.

Those who have visited this site cannot fail to be struck with the fair palaces, which, as under the wand of some magician, have risen like an exhalation from the soil. At the commencement of this year, when the first sod was turned by the Count De Manneville on behalf of the French Ambassador, the surface of the land presented the bare appearance of an ordinary farm. When the first stanchion of the Olympic Stadium was placed in position in August, huge skeleton buildings were beginning to appear upon the ground. These are now rapidly being converted into resplendent palaces as if the architect were the possessor of an Aladdin's lamp. The whole of the frame-work of the buildings is of steel, filled in with concrete slabs, thus forming a structure at once light, strong, and fire-proof, and capable of marvellous rapidity in erection.

Among the many beneficial influences exercised by exhibitions may be included the complete transformation of the anatomical structure of important buildings. Up to a few years ago all considerable edifices depended entirely for their support and stability on stone or brick, and it is chiefly due to the example set by exhibitions that steel, the characteristic of the present age, has become the main source of strength in buildings as in all other structures. Primitive man dwelt in caves, either natural or artificial. In the dim dawn of

humanity some troglodyte was inspired with the happy idea of erecting a cave on the surface instead of digging it underground. At first cyclopean stones and huge slabs of rock were used in the construction of these newly-invented dwellings, and although in course of time lighter and more shapely blocks were substituted, still stone and earth continued to furnish the main supply of architectural material. All this is now changed; buildings depend for their stability, both as regards tie and thrust, on steel, and although stone is still largely used in architecture, it is introduced chiefly for purposes of ornament, and merely forms, as it were, a panelling to fill up the spaces between huge pillars and girders of steel.

As might be expected from greater experience in exhibitions, as well as from the national inclination to system, the organisation of the French for the purpose of exhibitions is much more complete and effective than anything which exists on this side of the Channel. When the United Kingdom takes part in an exhibition, machinery is hastily improvised which performs its work as efficiently as such an extemporised contrivance will permit, and falls to pieces so soon as the occasion is over. In France a permanent body recognised by the Government, under the name of the Comité Francais des Expositions à l'Etranger, undertakes on behalf of the exhibitors, all that, which in this country, is performed by isolated effort, so that the experience derived from successive exhibitions is cumulative, and is for the future made available for each individual exhibitor.

Notwithstanding the importance attached to exhibitions by other nations as the best, and in the long run the cheapest mode of advertising, a good deal of apathy in regard to them has always existed in this country. The Departmental Committee of the Board of Trade which recently reported on the participation of Great Britain in international exhibitions states that there can be no doubt, from the personal point of view, they are not universally regarded with favour by manufacturers in this country. This reluctance to exhibit is traced to a variety of causes; it is asserted that exhibitions have, owing to increasing frequency, lost much of their novelty, and, from the vast size attained by universal exhibitions, individual exhibits are apt to pass unnoticed by the majority of visitors. In addition to the trouble and expense involved, many manufacturers are of opinion that they are liable to suffer serious disadvantage on account of their goods being copied at exhibitions by foreign rivals. A similar objection was made to the project of the Exhibition of 1851, and, seeing that Great Britain at that time possessed almost a monopoly of industrial processes, there may have been some ground for the charge. These conditions, however, no longer exist, other nations have manufactures equal, and in some respects superior, to our own; and if "in some instances exhibitors have experienced disadvantages through having their goods copied, they in turn do not fail to benefit by themselves inspecting the exhibits of their competitors." So far as the finished product is concerned, an equal danger of imitation is incurred in the fulfilment of a single order. Be this as it may, it must be borne in mind that the French are bent on making a display at this Exhibition superior to anything that has been seen out of Paris. Great Britain is their best customer, and they will lose no opportunity of placing their goods in attractive form before the buyer. It is to be noted also that important exhibits will be made by both the French and British Colonies; the latter expending approximately £150,000 in their display, and from their distant parts myriads of visitors will flock to the Exhibition. In addition to this, the Olympic games will attract a vast concourse of spectators from every quarter of the globe. From the indications derived from the applications already received there is every assurance that the British exhiblts will be worthy of the occasion, and indeed it would have been an imperial calamity if these visitors were confronted with an inadequate representation of the industrial capacity of the Mother Country as compared with that of our neighbours. The departmental committee places the matter in a nutshell when it remarks that "to a large extent the question which we have to decide is not whether it pays to exhibit, but whether under modern conditions we can afford not to exhibit. And is of opinion that the evidence obtained affords convincing proof that the answer to this question is in the negative."

The proposal of the Exhibition emanated from the French Chamber of Commerce in London and received the warm support of the French Minister of Commerce. A large representative meeting was held at the Mansion House on 11th July, 1906, with the Lord Mayor in the chair, when a resolution in favour of the Exhibition and approving the steps already

taken was unanimously passed. It was resolved that all profits resulting from the Exhibition should be devoted to some public purpose to be jointly determined upon by representatives of the two countries concerned.

The exhibits will be classified and arranged in the following groups :—

Education.—Elementary, higher elementary, and continuation schools. The education of defectives. Secondary education. Higher and university education. Technical, industrial and agricultural education. Teaching of Fine Art and Music.

Science.—Historical apparatus. Instruments and experiments and observations. Exploration of the land. Exploration of the sea. Exploration of the air. Exploration of the Heavens.

Fine Arts.—Paintings, cartoons, drawings, etchings. Engravings. Sculpture. Architecture.

Liberal Arts.—Typography and various printing processes. Lithographs. Photography. Books and publications, newspapers, posters and bookbinding. Maps and apparatus for geography, cosmography and topography. Mathematical and scientific instruments. Coins and medals. Medicine and surgery. Musical instruments. Theatrical appliances and equipment.

Engineering and Shipping.—All branches of engineering will be illustrated. Constructional, mechanical, gas, electrical, mining, metallurgical, marine and shipbuilding. Exhibits will include materials of construction, plant and processes. Methods of generating power; steam, gas and electrical. Working of mines and quarries, ores and minerals. Methods of manufacturing iron, steel and other metals. Steam and gas engines. Electrical motors and utilisation of electricity, telegraphy and telephony. Electric and gas lighting. Models, plans and drawings relating to docks, harbours, and works of construction; to warships and merchant ships. Motors, machinery, and machine tools. Shipping will include exhibits of the great passenger steamship lines, cargo steamers, cross Channel and coasting steamers, &c., material and equipment of warships. Armaments and equipment of warships, including guns, gun mountings, submarine mines, lecomotive torpedoes, and special mechanical appliances.

Transportation.—Carriages, wheelwrights' work, motor cars and cycles. Road vehicles. Saddlery and harness. Railway and tramway plant. Inland navigation. Aerial navigation.

Agriculture and Viticulture.—Farm equipment and the methods of improving lands. Agricultural implements and farm machinery. Fertilisers. Appliances and processes used in agricultural industries. Agronomy (theory of agriculture). Agricultural statistics. Agricultural food products:—(1) Vegetables. (2) Animals. Inedible agricultural products. Useful insects and their products. Noxious insects and their prevention.

Horticulture, Arboriculture, Forestry and Fisheries.—Appliances and processes used in horticulture and arboriculture. Seeds and plants for gardens and nurseries. Fruits and fruit trees, pomology and cider making. Trees, shrubs, ornamental plants and flowers. Greenhouse and hothouse plants. Appliances for gathering wild crops and products obtained. Appliances and processes used in forestry. Products of the cultivation of forests and of forest industries. Hunting and shooting equipments. Hunting and shooting products. Fishing equipment and products. Pisciculture.

Alimentation.—Equipment and methods employed in the preparation of foods. Farinacious products and their derivatives. Bread and pastry. Preserved meat, fish, vegetables and fruit. Sugar and confectionery. Condiments and relishes. Wines, various spirits. Syrups and liqueurs. Commercial alcohols. Various beverages, fermented beverages, and other waters.

Decoration and Furnishing.—Decoration and fixed furniture. Plumbing and sanitary appliances. Wall papers and paper hangings. Household, art and office furniture. Carpets, tapestries and fabrics for upholstery. Upholstery and upholsterers' decoration. Ceramics (pottery and porcelain). Glass, crystal and stained glass. Apparatuses and processes for heating and ventilation. Apparatns and methods (not electrical) for lighting.

Textiles.—Appliances and processes of spinning and rope making. Plant and processes used in the manufacture of textile fabrics. Appliances and processes used in bleaching, dyeing, printing and finishing textile materials, their various stages. Appliances and processes used in sewing and making wearing apparel. Thread and fabrics of cotton—Threads and fabrics of flax, hemp, &c. Cordage. Yarns and fabrics of wool. Silk and fabrics of silk. Laces, embroideries and trimmings. Industries producing wearing apparel for men, women, and children. Various industries connected with clothing.

Chemical Industries.—Applied chemistry and pharmacy. Manufacture of paper. Leather and skins. Perfumery. Manufacture of tobacco and matches.

Various Industries.—Stationery. Cutlery. Goldsmiths' and silversmiths' ware. Jewellery, precious stones. Clock and watch-making. Artistic productions in bronze, marble, cast and other ironwork. Embossed metal. Art leather-work, basket-work, brushes and fancy articles. India-rubber and gutta-percha industries. Travelling and camping requisites. Toys and knicknacks.

Social Economy, Sanitation, Public Relief.—Study and investigation of social and economic conditions. Economic resources and organisation. State regulation of industry and labour. Organisation of industrial workers. Methods of industrial remuneration, profit sharing. Provident institutions. Co-operative production and distribution. Housing of the working classes (urban and rural). Hygiene and sanitation. Public relief. Charity organisation. Movements due to municipal or private initiative for the social and economic betterment of urban life.

Women's Work.—Domestic and industrial training. Arts and crafts. Social and philanthropic institutions.

Trade and Colonisation.—Commerce, trade and banking. Methods of colonisation. Colonial buildings and appliances. Special products suitable for colonial export.

Sports and Physical Culture.—The training and physical development of children and adults. Games and sports for children and adults. Equipment for games and sports.

In order that the British Section shall, on this occasion, have the advantage of the experience not only of the French but of other nations who have made elaborate and tasteful displays at former great international exhibitions, the Executive Committee have decided that they will retain the undermentioned arrangements in their own hands, making a small charge to assist in providing for the expenses of such services.

Steps will be taken to provide that the whole of the various sections shall be decorated in a harmonious, artistic and tasteful way so that the courts or decorated divisions of each group shall practically form a scheme complete in itself.

In order that every possible facility shall be given to exhibitors, the Committee will take charge of the receiving of the goods at the respective exhibition buildings for which the exhibits are destined, so that workmen employed by the exhibition authorities will place them in their packing cases (if any), on the space allotted to the respective exhibitors, who will forthwith unpack them. The cases will then be removed by the workmen of the authorities and stored and finally brought back for repacking the goods by the exhibitor at the close of the exhibition.

It having been found that a great deal of business has been lost in other exhibitions on account of insufficient information being available of the various exhibits through lack of proper knowledge on the part of the exhibition attendants, the Committee have decided to employ a sufficient staff of well-informed men, who will be capable of giving full information concerning any of the exhibits in their particular group or class.

A most important feature on which the commercial advantages of any exhibition greatly depends, is the establishment of a Commercial Bureau from which the intending buyer will be able to receive the fullest possible information concerning all goods displayed in the exhibition, and to obtain particulars as to the place where each exhibit can be found, together with the literature concerning it. This has never before been attempted in any exhibitions held in the United Kingdom, though it was successfully done at the Paris Exhibition, 1900, and the St. Louis and Chicago Exhibitions. The Commercial Bureau will practically be the servant of all exhibitors, as well as of the public, and will greatly facilitate business transactions.

With a view to contributing towards the above expenses the Committee have decided to make a nominal charge of 1s. 6d. to 2s. 6d. per superficial foot of the space occupied by each exhibitor, and to arrange a graduated scale of prices so that the exhibitors, who, by the nature of their exhibits, are obliged to take up a large space, *e.g.*, furniture, machinery, carriages, &c., sanitary installations, &c., will have the advantage of a lower price than those who only take up a small space.

The tariff for space, and the contribution towards decoration, handling of goods, information attendants, general lighting of halls, police, and fees of Commercial Bureau, will be as follows:—

Exhibit space in the interior of buildings.	Price per foot square including one frontage.		Decoration of section; handling of goods; of cases up to 250 pounds each; information attendants; general lighting of halls; police; and Commercial Bureau fees.		
Up to—	s.	d.	s.	d.	
,, 50 sq. ft.	10	0	2	6	This fund will be solely used for the purposes set forth, by the respective Group Committees, and any surplus will be returned *pro rata* to each exhibitor at the close of the Exhibition.
,, 100 ,,	9	0	2	6	
,, 150 ,,	8	0	2	6	
,, 200 ,,	7	0	2	0	
,, 300 ,,	6	0	2	0	
,, 500 ,,	5	6	2	0	
,, 750 ,,	5	0	1	6	
,, 1,000 ,,	4	6	1	6	
,, 1,500 ,, or over	4	0	1	6	

Minimum charge for individual exhibits £20

Minimum charge for collective or groups of exhibits .. .. £5 each exhibitor.

Charge for more than one frontage will be as follows:—

	Per foot additional frontage.
Central avenues	10s.
Main avenues	8s.
Side avenues	6s.
Other frontages	5s.

As might be expected from the dual nature of the Exhibition, one half of the space will be devoted to French, the other half to British exhibits. For example, the Palace of French Industries is on one side of the Court of Honour, that of British Industries on the other. The British Colonies occupy the left of the plan, while the French Colonies are situated in the right. But in this bilateral arrangement there will be no attempt to secure a rigid symmetry. The corresponding buildings will not be counterparts the one of the other; while bearing mutually a harmonious relation, each will have its distinguishing features of outline and decoration. There will be that diversity in agreement which is the soul of harmony. It

will not be as in the famous description of a mechanically balanced garden, where

> "Grove nods at rove, each alley has a brother,
> And half the platform just reflects the other."

There are palaces of applied art, of women's work, of decorative work of music and of fine art; in the latter the French and British exhibits will occupy opposite sides of the same building. There is an Education Hall and a Hall of Electricity. The Machinery Halls contain about 300,000 square feet of space and form three sides of a huge quadrangle, within which, together with other municipal edifices, will be situated the pavilion of the Ville de Paris, on which the Municipality of Paris is expending a sum of £12,000. The foundation stone of this structure was laid by Monsieur Le Fevre, the President, in the presence of the French Ambassador and a delegation of the Municipal Council.

Embosomed in delightful gardens there is a graceful structure which will be used as a royal pavilion. There will also be a Garden Club and a Sports Club. Standing on an island with three causeways, in a central lake, rises, with slender aspiring lines, the Imperial Tower.

The palaces of the Exhibition, some 20 in number, are surrounded by gardens laid out by the best French and English landscape gardeners. The space in the centre of the Exhibition area, lying between the Imperial Tower, the Franco-British Pavilion, the Palace Restaurant, and the Garden Club, will be known as the Elite Gardens; adjoining this is the Court of Arts, encircled by lagoons, on which boats and launches will ply with passengers, the total navigable distance, including the lake in the Court of Honour, being nearly five-eighths of a mile.

In a galaxy of enchanting scenes, the Court of Honour will glitter like the queen jewel in a cluster of gems. Here is a spacious lake, spanned by a bridge strong enough to bear the tramp of an army, but with tracery, airy, and gossamer as a strand of coral. At the head of the lake a cascade leaps in musical cadence down a terraced fall. On the bridge and at intervals jutting into the water from the sides of the lake are stationed dainty pavilions, in which visitors can sit and enjoy to the full the surrounding delights. The scene will be surpassingly brilliant by day, but at night, when a thousand dazzling lights make dim the stars, and are multiplied myriad-fold in the broken reflection of the waters, whose surface is stirred by a procession of gaily-decorated craft; when by an ingenious arrangement of electric beams, the hues of the rainbow are refracted through the cataract in a scheme of bright and ever-changing colours, the sight will be one to bewitch the beholder, and the *chef-d'œuvre* of Mr. Imre Kiralfy, one of the greatest living masters of form and colour, will long dwell in the memory as a beautiful dream.

A special committee has been appointed to provide for the comfort of visitors from the country and abroad. Not only the classes, but the masses of the French people will be attracted to the Exhibition, and it is safe to predict that numerous and lasting ties of personal friendship will be the result. There is no room for doubt that the Exhibition will advance industry, extend trade, and still more strongly cement the bonds of amity which now so happily exist between the neighbour nations. But there is yet a deeper significance and wider scope in a movement so well calculated to bring the respective peoples of two great powers into intimate acquaintance. No nation can live for itself alone. The first International Exhibition in 1851 was called the Congress of Peace. May we not look upon the Franco-British Exhibition as one of the most potent influences in placing on an assured basis the peace of the world.

DISCUSSION.

The CHAIRMAN, in opening the discussion, stated that as Chairman of the Executive Committee, he had been impressed with the enormous amount of work which had to be done in a variety of directions by those who were carrying out, from day to day, the business of preparing a great exhibition. In the first place, one had to picture an area of 140 acres, about a quarter of a square mile, of those desolate-looking fields which were seen on the suburbs of London, which looked as though they were tired of being country, and not quite ready to be town. It might seem a very simple thing to put up iron buildings upon a flat piece of green, but it would be found that that was not the case when they had to be erected under the rules of the London County Council, because a vast number of regulations, all of which were founded upon the simple desire to guard the health of the people of this great city, had to be complied with. In addition to that, drainage works had to be provided, and arrangements made for gas and water. Of course, that was a very simple matter when a building was erected fronting a main road, it only being necessary to lay down a service pipe, but in the case of the Exhibition, mains had to be laid over a square quarter of a mile. The planning, making the arrangements with the contractors,

and consulting with various authorities, was also a large piece of work. Then the buildings had to be erected; and he confessed that, after recently seeing the buildings, he had been vrey much struck with their beauty and simplicity. One of the most difficult problems in connection with the building of an exhibition was the most economical method of erecting a building which, although it was only to be used for a year, had to satisfy the rules of the London County Council as to its strength and other qualities Mr. Imre Kiralfy was responsible for the speed, regularity and success with which that enormous amount of work had been carried through, and he certainly had the greatest genius for performing work of that kind of any man in the civilised world. His knowledge of every branch, beginning with the drains down to the very finest specimens of architecture, and also his knowledge of business matters in connection with building contracts, was most extraordinary; and it was a wonder to him how one man could not only know all those things, but find the physical strength to enable him to do the work he was performing at the present time. The Exhibition authorities were much indebted to him; and it was only right that a word should be said in recognition of his splendid capacities. One thing which had particularly struck him was the simplicity and at the same time the strength of the method of building that had been adopted; and he hoped many of the audience would take the opportunity, when the buildings were a little more advanced, of judging whether any better scheme could possibly have been devised for covering in so short a time such a large area of ground. One or two things had not been mentioned by the author to which he desired to call attention, the first being the Art exhibit. He believed the French would have an excellent exhibition of that kind; and one of the very finest exhibitions of English pictures, if not the finest, that had ever been seen would also take place. After looking at machinery and other interesting exhibits, the eyes were apt to get tired, and it was exceedingly refreshing to be able to go into a fine picture gallery and rest them, knowing at the same time that one was seeing more beautiful specimens of art than one was likely to see gathered together in any place in England for some years to come. The pictures were exhibited for the pleasure of the public, and no profit, direct or indirect, would be made by the owners of the pictures who exhibited them. Excellent provision would also be made at the Exhibition in the way of clubs and opportunities for refreshments, which were necessary annexes to a large exhibition frequented by a great number of people. The club would be housed in a building close to the Stadium, and he had no doubt would be very much used by the visitors, while the general refreshment rooms would be no doubt largely patronised by the great mass of the people. Another most important part of the Exhibition was that connected with education. He supposed anyone might have gone right through the Exhibition of 1851 without finding any exhibit connected with education, except a few specimens of the latest patterns of desks and forms for children and masters; but Sir William Mather, the able and energetic Chairman of the Education Committee, had informed him that there would be a very complete and interesting exhibit in the Department of Education. Education was so much better furnished than it was 50 years ago that there was no comparison between what could be exhibited then and what would be exhibited now; and he was very glad to think that the exhibit in that department would contain the very perfection of all that was to be seen in connection with education as now carried on in England in primary and secondary schools.

Mr. Imre Kiralfy stated that after the very kind words which had fallen from the Chairman with regard to his work connected with the Exhibition he felt one of the proudest men that had ever lived. The author of the paper had been associated with the Exhibition from the very first, and had taken the greatest possible interest in it: in fact, but for his interest the Franco-British Exhibition would not have been *une affaire accomplie*. A deep debt of gratitude was due to Sir John for the great part he had taken in the work. He (Mr. Kiralfy) also desired to emphasise, having been closely associated with Lord Selby, the vast amount of work he had performed, and it was largely due to his work that the Exhibition would be a great success.

Mr. J. Tripplin desired, as a Frenchman, to thank the author for the exceedingly graceful expressions he had used with regard to the French people. His words would be reported in France, and he was sure would be fully reciprocated.

Sir Boverton Redwood thought there could be no doubt that the paper had been delivered most opportunely, because there were many who must have found a lack of desirable knowledge in respect of the aims and scope of the Exhibition. To some extent he feared that the prominence which had been given to the holding of the Olympic games was responsible for that erroneous view, having led to the impression that the other features of an international exhibition would occupy but a secondary position. The author's able address had, he was sure, effectively dispelled any such view, and he hoped that those manufacturers who had not already applied for space would at once commence the preparation of exhibits worthy of this country, bearing in mind the fact that France was unquestionably making an exceptional effort on the present occasion. Allusion had been made by Sir John to the recent inquiry by a committee appointed by the Board of Trade, and he had referred to a circumstance which was well within his own knowledge, namely, the reluctance on the part of manufacturers to take part in exhibitions. He had had in former years, in respect of previous

exhibitions, the thankless task of organising exhibits of an industrial character, and he knew what the feeling was; but he knew also that those manufacturers who had exhibited effectively had seen reason to be satisfied with the action they had taken. In that connection it was worthy of note that the committee, having heard evidence from all persons interested in matters of the kind, deliberately arrived at the conclusion that it was in the best interests of this country that Great Britain should continue to take part in international exhibitions. Those who were privileged to attend the reception recently held by the Duke of Argyll, Lord Selby, Sir John Cockburn and his associates at Shepherd's Bush, must have seen ample evidence that there was full justification for the most favourable anticipations in regard to the splendour of the approaching Exhibition. Personally, he was a little more interested in the internal economy of the buildings than in the mysteries into which the audience had been initiated in regard to their construction; but the manner in which the reception was organised by Mr. Kiralfy, and especially the steps which he took to furnish the visitors with full information as to the character the Exhibition would have on its completion, afforded the most happy augury for the success of the Franco-British Exhibition of 1908.

Mr. M. Warner, speaking as a manufacturer, said he desired to refer to the point which had been raised as to the disinclination of manufacturers sometimes to exhibit at exhibitions. One of the reasons which was standing in the way of manufacturers taking a great interest in the Franco-British Exhibition was that it was not being conducted in the same way as international exhibitions. In such exhibitions there was generally no charge for space; but in the present instance a very excessive charge was made which, in his opinion, entirely prevented small manufacturers from taking the part they had been accustomed to fill. That would prevent many manufacturers who had taken international medals at almost all exhibitions from exhibiting. They felt that the cost of the advertisement would be too great. If all the expenses of exhibiting were added to what he considered the very excessive amount which was being charged for space, it meant that in many cases it altogether precluded some manufacturers from participating in the Exhibition, which meant that the Exhibition would simply be an Exhibition for wealthy manufacturers and limited liability companies, who had plenty of capital at their backs. He also thought it was unfair to take money from manufacturers and then, if a profit was made, instead of giving them a rebate, to hand it over to some institution as had been suggested. He thought those who made the Exhibition by exhibiting, especially when one remembered the enormous expense to which they were put, should have more consideration given to them than they had hitherto received.

Sir Henry Trueman Wood (Secretary of the Society) said that although the last speaker's remarks could be perfectly well answered by someone who was authorised to speak on behalf of the Exhibition, they could also be answered by one who had had a great many years experience of exhibition work. He asked any exhibitor to think how the expenses of an exhibition were to be paid, unless he was charged for the space he occupied, or unless there was a considerable contribution from the State, or from the country holding the exhibition which would pay the very large balance of loss which every big exhibition must incur. In large international exhibitions, like those in Paris, Chicago, St. Louis, and elsewhere, the deficit was tremendous. The Chicago Exhibition cost £6,000,000, and only £3,000,000 were received from all sources, the deficit being made up by contributions from the people of Chicago and the United States. That had been the case with all other exhibitions, great international exhibitions, except the first, 1851. The Franco-British Exhibition was on a smaller scale, and it might possibly just pay its expenses by means of the various sources of revenue which were well known to those who dealt with exhibitions, namely, the entrance fee paid by the public, and the various concessions for refreshments and other purposes. But without some contribution from somewhere it was absolutely and entirely impossible for any exhibition to earn in a single year sufficient money to pay for its buildings and its working expenses unless it was on a small scale. Exhibitions like the Inventions, the Health, and the Fisheries were on a small scale, and earned sufficient money; but exhibitions like those of Paris, St. Louis, or Chicago had not the time to do so. If they could be kept open for three or four years, certainly not less, they might be able to pay their way. He thought exhibitors must remember that the money had to come from somewhere, and unless the public, the Government, or the Municipality would provide it, they must put their hands in their pockets and pay what, after all, was a very small proportion to the cost of exhibiting. Speaking as one fully acquainted with all the facts, he knew that the cost of any charge for space was a very small amount compared with what a manufacturer had to pay for the total cost of his exhibit at an important exhibition. He had made his remarks from a purely disinterested point of view, because he had no interest in the Franco-British Exhibition except a friendly wish for its welfare; and he thought that, speaking as one who had had a very long experience of exhibitions, it might be as well that an independent view should be given.

Mr. Frank Debenham desired to support the remarks made by Sir Henry Trueman Wood. Obviously the cost of an exhibition must be defrayed from some source, and in his opinion nothing could be fairer than that the manufacturers should

pay according to the space occupied by their exhibits. He had corresponded during the last few weeks with an enormous number of manufacturers connected with not the least important of the groups of the Exhibition, and he had not found the objection to which Mr. Warner had referred urged to any serious extent. Where it had been urged the committee were endeavouring to meet it, and he thought successfully, by the system which had been adopted by the French for many years, namely, that of collective exhibits. In that way applications would be received for a larger amount of space, and consequently the price would be considerably reduced, while at the same time the expense was distributed among a large number of people, so that it was only lightly felt by each. The manufacturers of Great Britain had always been reluctant to come forward at exhibitions; it was the case in the first Exhibition of 1851; but their comparative apathy was being very rapidly dispelled, and he hoped the reading of the paper would go still further to dispel the ideas which had hitherto existed among the manufacturing community. The Anglo-Saxon race was generally very late in taking up any project, but when it did so, in the end it came out at the top, and he believed that would be the case with the Exhibition of next year.

Mr. Imre Kiralfy desired also to reply to Mr. Warner's remarks, as he was responsible for the scale of prices which had been adopted at the Exhibition. He was the British Commissioner-General a few years ago at the Liège Exhibition, where the price charged to British exhibitors was much higher than that being charged at the Franco-British Exhibition. In addition, British exhibitors had to pay the freight to and from Liège. In the present Exhibition that expense would be considerably less, because the Exhibition was close at hand. Further, at Liège, exhibitors had to pay for their installations and decorations, an expense which would be borne by the Executive Committee of the Franco-British Exhibition, thus considerably lightening the expense of exhibitors. Having studied the subject thoroughly, he considered that never in any exhibition of such importance had the prices been as low as they were for the Exhibition next year; and judging by the large number of cheques which were coming in daily without any complaint, he assured the audience that as far as the exhibitors were concerned, the Exhibition would be a great success. Among the hundreds of applications which had been received, he did not believe there had been more than two or three in which it was stated that the prices were high.

Mr. C. Rozenraad, in referring to not only the direct but the indirect advantages the Exhibition would confer on the metropolis, said that in the first place it would be a confirmation of the *entente cordiale* so splendidly established by His Majesty, and so successfully carried out by the two Governments. In the next place all branches of industry and commerce would feel the benefit of the Exhibition, because people would come from all parts of the world to admire what the two nations could do in the way of industry and progress. Speaking as a banker, he knew that that would affect the rate of exchange, and instead of having, as at present, a 7 per cent. bank rate a much lower rate would prevail. Australian, French, and American gold would come into this country, so that the gold which was at present being shipped to the other side of the Atlantic would eventually come back to it. In his opinion, the organisers of the Exhibition were working in the interests of the economic development of two great countries which had played an important part in civilisation and humanity.

The vote of thanks to Sir John Cockburn for his interesting and instructive paper was then put and carried unanimously; and Sir John having briefly acknowledged the compliment, the meeting terminated.

COTTON IN THE WEST INDIES.

Sir Daniel Morris's dispatch to the Colonial Office on the progress of the cotton-growing industry in the West Indies, just made known, and dated August 12th last, affords gratifying evidence of the growth of cotton cultivation in the British West India islands during the five and a half years ended June 30th, 1907. In 1903, Sir Daniel Morris and Mr. Bovell visited the Sea Islands of the United States. At that time the planters had not fully made up their minds as to the kind of cotton, whether Upland, Egyptian, or Sea Island best suited to West Indian conditions. After carefully studying the circumstances connected with the cultivation of Sea Island cotton in the Sea Islands, Sir Daniel Morris decided that the West Indies should confine their attention entirely to Sea Island cotton. This cotton was originally a native of the West Indies, but the quality of the staple has been greatly improved by cultivation over a long period in the United States. Sir Daniel Morris took steps to secure a sufficient quantity of seed to plant 7,000 acres, and got it from an estate that for the last fifty years has produced a high quality of lint which has obtained uniformly good prices. The seed was at once taken up by the West Indian planters, and a Sea Island cotton industry was given a start on commercial lines. The result was shown in the increased value of the exports for the following year, and in the steady increase in the exports up to the present time. Owing partly to enhanced prices exports during the half year ended June 30th last reached an estimated value of £154,976, or, adding the value of the seeds to that of the lint, of £167,664, while the total value of the lint and seed exported during the five and half years amounts to £374,486.

Sir Daniel Morris refers in language of warm appreciation to the assistance and encouragement rendered

to the West Indian cotton industry by the British Cotton Growing Association. The assistance rendered to the planters by the Imperial Department of Agriculture for the West Indies is even more marked. Indeed, it is not too much to say that without it there would have been no increase in the cultivation of cotton in the West Indies worth talking about. At present, about 80 per cent. of the seed used for planting purposes is selected, and also distributed by the Department. In Sir Daniel Morris's opinion, "there is no reason why the West Indies should not continue to improve the quality of the seed produced locally, and thus become independent of supplies from other countries. The general aspects of the West Indian Sea Island cotton industry are, therefore, of a distinctly promising character, and there is every probability that the value of the exports in future years will steadily increase." But Sir Daniel Morris, while rejoicing in a new industry of considerable value, considers it incumbent upon him "to place on record that the cotton industry, even if it is further developed, cannot entirely take the place of the sugar industry, upon which the welfare and prosperity of so many of these colonies have hitherto depended . . . . The decay of the sugar industry would throw back the general prosperity to such an extent as to counterbalance the good results arising from the development of other industries, such as cacao, fruit, cotton, limes, rice, rubber, tobacco, &c." This opinion may meet with some dissent. Probably, so far as British Guiana is concerned, which is apparently unsuited to the cultivation of Sea Island cotton, there will be pretty general assent, but hardly as to the islands. For generations the cultivation and manufacture of sugar were highly profitable in the West Indies, but at present prices, even in Barbadoes, where there is a superabundance of cheap labour, sugar shows only a meagre profit. On the other hand, Trinidad, Jamaica, and some of the lesser islands, have been saved by abandoning sugar cultivation for that of cacao, as in Trinidad and Grenada, and fruit and other products, as in Jamaica.

THE PHENOMENON OF THE SOUTH-WEST MONSOON.*

By Sir George Birdwood.

The Western Ghâts or Sahyadri Mountains are the crest of the great wave of trap covering all the Deccan from Gwalior and Nagpore to the Concans, and overhanging the latter like a rampart of the Titans. This rampart lies almost at right angles to the South-West Monsoon, which beating on it through sunless ages has worn it into its characteristic peaks, and table-lands, and spurs. On the eastern side, the slope of the trap wave being gradual, the Sahyadri range presents spurs which sometimes stretch almost across the Deccan, in the plain of which they are at last lost. Thus the Deccan is divided between the open country and the hilly. The open country they call *desh*, and the hilly tract between Poona and Sattara, or more properly the mountain valleys of the Neera, Kistna, and Yenna, they call the *mavals*, the cradle of Sivajee's *svairaj*, or "own dominion." South of Poona, the capital of the Peishwas, and Cabul of the Deccan, stretches the Katruj Ghât spur and its ramifications, crowned by the inspiring ruins of Sivajee's old strongholds, Poorundhur, Singhur, and Toorno; and south of it the plateau of Mander Deo†, the water-parting of the Neera and Kistna; and beyond the latter spur rises the polypus-like mountain mass of Mahabaleshwur—"the Great Strength of God"—whereupon sometimes 600 inches of rain descends from June to September. Into the Concans the Ghâts fall either abruptly in sheer precipices, often of 2,000 feet scarp, or in short spurs of tableland and peaks, which groyne this narrow maritime region into a series of *murhen* or "steamy" glens. On one of these spurs, in front of Mahabaleshwur, stands Sivajee's famous fortress of Pertabghur; and on another, only three hours' distance by rail from Bombay, and lying between the "districts" of Callian and Panwell, Lord Elphinstone founded the sanatorium of Matheran—"the Supernal Forest." Rising abruptiy from almost the sea level, and standing like an advanced tower in front of the Ghâts, that seem to end to the north-east in the stupendous scarp of the Hurrychunderghur, it commands the most striking and picturesque scenery, while constantly cooled by the sea-breeze, and screened by the Ghâts about Khandalla from the land wind, its vegetation is greener, nobler, and more varied than that of much higher summits of the Ghâts themselves. With the twin-table-mountain mass of Prabal—"the Almighty"—and the pinnacle of Funnel Hill, it is the dominant landmark on entering the harbour of Bombay, and in the sultry chasms and abysses, or *khoras*, between Matheran and Prabal and Khandalla the thunders of the Monsoon at Bombay are generated. Matheran, is, in fact, the elevated tableland portion of one of the innumerable spurs of the Sahyadri range falling across the Concans into the sea; and generally leading to a *ghât* or pass through the main range running north and south. And this Matheran spur, continued north-westward in the weirdly jagged crest of blasted pumice peaks called Bhau Mulleng, before finally sinking into the Arabian Sea, forms the bright little archipelago of palm-tufted islets which, joined together by the clay deposit of "the Flats" and the white strand of shells heaped up by the waves of the South-Western Monsoon along "Black Bay," constitute the island of Bombay, with its sea groves of cocoanut, and wide, grassy, esplanade, and glowing gardens of strange outland flowers and fruits; while at the other end of the spur, at Khandalla, forty

* Originally published in the *Times* of 6th Jan., 1880. The introduction of the article, The Mechanism of the Monsoons, appeared in the *Journal* Oct. 11th, 1907. (Vol. lv., p. 1070.)

† Described by me in the *Friend of India* of March 1, 1866.

miles south-eastward of Bombay, we have the deep cleft or gorge [*khora*] in the Sahyadri barrier, called the "Bhore Ghât," the only practicable pass to and fro Bombay and Poona. Between these points the Matheran spur lies extended like a horseshoe, thus determining the course of the Callian, here called the Opsala, river, flowing, under its eastern and northern declivities, from the Bore Ghât, past the ancient port of Callian—undoubtedly known of the Chaldeans "whose cry" was "in their ships," and to the navies of the Pharaohs and King Solomon, manned by the "go-a-ducking Phœnicians,"—and past the mediæval port of Tannah, into Bombay Harbour, the great modern port of Western India. As in fact the Callian river silted up, the port had to be removed further and further seaward. The southern and western declivities of the hill overlook the courses of the Panwell and Nagotna rivers. From all points one looks down, and back, and around on tremendous basaltic precipices, glittering waterfalls, wooded gorges, and irregular, rugged spurs; and above all the vast overhanging forest of Matheran, cool, green, and joyous with the song of birds, and so wonderfully contrasted against the scarred and blackened ridge of Bhau Mulleng. Far below lie the misty plains of the Callian and Panwell rivers, and beyond them, westward, the Arabian Sea, with Bombay, the sanctuary of the eponymous goddess Mambai, in all the magnificence and pride of her commercial prosperity, lying in it, diminished in the long perspective, as to a minnow one might take up out of the water in the hollow of the hand; and eastward the loom-line of the Sahyadri mountains, with the arches of the Bore Ghât Railway incline just visible through the loom. Such is the romantic physical and historical theatre of the burst of the Monsoon in Western India over Bombay.

The grand spectacle of the phenomenon will be best described by the following extracts from observations made by the writer at Matheran of the burst of the Monsoon of 1865. It began on Monday, June 6, at 3.30 p.m., with sullen thunder in the north-west, where the clouds had all day long been rolling up in towering electric piles. As the clouds thundered they moved slowly down through the Northern Concan, and gathered at 4 p.m. along the fantastically engrailed volcanic sky-line of Bhau Mulleng. All along Bhau Mulleng and northward, the sky and land were filled wtih lurid clouds and shadows, and thunder, lightning, and rain, the Callian [Opsala] river flowing black as ink through a scene of the most oppressive desolation and gloom; while, all southward of this abrupt line of storm and shattered peaks and pinnacles, the whole country from Bombay to the Bhore Ghât was lighted up with a pure, serene light, that made it shine like the plains of heaven. Every village, every hut, every road, and every jungle-track, even the bridge over the river at Chowk, came distinctly into view. The trees and groves looked magically green; and the light picked out the most hidden streams of water, and made them glitter in threads of molten silver. The Panwell and Nagotna rivers shone like mirrors, and the Arabian Sea seemed ruled, so far as it could be distinguished from the sky, with lines of this vividly reflected sunshine. The contrast with the outer darkness around and beyond Bhau Mulleng was almost theatrical. Suddenly, at 4.45, the storm-rack rushed headlong down over Bhau Mulleng like a tumultuous sea, and rapidly moved into the profound valley between Matheran and Prabal, the wind blowing furiously, and the rain pouring in torrents, accompanied by the most awful peals of thunder and flashes of forked lightning. But when it had filled the valley the rain and the wind ceased, and the storm-rack stood still, and for one hour in that dead stillness (4.50 to 5.50 p.m.) the thunder and the lightning, both in horizontal and perpendicular bolts, raged without a moment's intermission. The thunder mostly rolled from end to end of the valley, but sometimes seemed to explode in its midst like a shell, and with a force as would burst the bonds of the surrounding hills. The detonations were instantaneous with the bolts. Once in the dreadful stillness the thunder came with the sound of a terrific rushing hiss, although not a breath of air stirred the meanwhile. At 6 p.m. the storm again moved and passed slowly southward over Prabal towards the Nagotna, and another enchanting scene was opened up in the southern Concan. Every hut and tree and stream became preternaturally clear, the inundated rice fields and rivers flashing like steel, while fleecy clouds lay on every hillock and slowly crept up every ravine. Then, as the sun set behind Bombay, the whole scene became tinctured over with a glorious halo of soft golden light. The summits of the hills westward towards Tannah were irradiated with every hue of golden light, passing gradually into deep purple, the while the Callian river flickered out in burnished gold between them. It is impossible to describe the transient glory of this scene. Then the moon rose and illuminated the fog that had now gathered out of the ravines and off the hills and formed an aerial street stretched in frosted silver right across the calm, clear heavens from north to south; while high up in the south, but seeming to lie from east to west, stood the black, embattled storm-rack towards Mahabaleshwur, belching forth flame and thunder the whole night long. The next day (Tuesday) passed off without a storm; but on Wednesday, the 8th, the sky was again filled with vast electrical cloud-banks eastward toward the Bore Ghât. At 2 p.m. muttering thunder was heard from this direction, when the sky became oppressively over-cast and lurid. At half-past 2 the storm moved westward, travelling in the opposite direction to its course on the 6th directly on Matheran. A mist went before it, thickening as it went, first into trailing clouds, and then a dripping rain, muttering thunder all the while. At 3 p.m. the valley between Matheran and Prabal was filled with the storm, which now began to thunder in long, reverberating peals,

the lightning illuminating the dense fog in which it seemed to be generated with extreme splendour. Heavy rain accompanied the illuminated fog until 3.45 p.m., when a light wind suddenly swept it all off westward towards Bombay, and showed that a heavy rain had fallen all over the whole country. At 4 p.m. the storm seemed concentrated above Bombay. Just then another dense fog, but luminous as magnesium light, again filled the valley between Matheran and Prabal, and the dlstant storm could no longer be watched; but the newspapers of the next morning, when they were delivered at Matheran, told us that on the previous evening the Monsoon had burst in Bombay.

Another year the Monsoon was ushered in with a very picturesqe phenomenon. About 2 p.m. masses of cloud came along the plain from Khandalla on Matheran, and as in succession they rounded the high basaltic scarp of Chowk Point exchanged regular broadsides of lightning and thunder with it. The sky was perfectly clear all the time, and the salutation between these clouds and the mountains was repeated for a day or two before the great burst. It was exactly like the bombardment of a great casemated fortress by a fleet of ironclads [of the type of 1854-5] in full sail. Once the Monsoon burst without thunder. The clear sky suddenly turned black, and one universal solemn downpour set in, and continued for about 36 hours.

Always these appalling electric outbursts close serenely. The storm clouds retreat hilariously, like a drove of bellowing bulls, their last echoes dying away beyond the distant wall of mountains; the sun shines forth again in majesty; fragrant with the freshening breath of a myriad opening flowers, the winds fall to a "cheerful note;" in every dell the delicious sound of running waters reawakens life; the woods become vocal with the glad songs of birds; and the heart of man is filled with an exalted joy in the contemplation of the sublime manifestations of that beneficent Power by which the face of Nature is renewed in perpetual youth and glory and praise. It is the sudden rapture of the untaught and instinctive vision of the absolute unity in infinite diversity of all existence and being,—the magic mood that spiritualises sense, and through this passing show of things reveals the things that are imperdible and eternal.

It was on a morning of "clear shining after rain" such as this, that the late Sett Premchand Roychand in a sudden transport of devout gratitude and good-will, flung high up into the heaven above Bombay his far echoing appeal of Joy Bells, in the stately tower of the University consecrated in the name of his beloved Mother, Rajabai.

Post Scriptum, 1907.—One of the most moving passages in Sanscrit literature, I will say in all literature, is the hymn in the "Rig Veda" to the toads and frogs on their grateful welcome of the "greater rain" of the S.W. and N.E. Monsoons; and on first hearing it, I at once had it engraved, as Englished by myself, on the belly of the brazen image of a toad:—

"When the Monsoon bursts in lightnings and thunder, on the day when the great rain pours down upon the overclouded world, the frogs in their sudden joy, leaping out upon the fragrant earth, join in rapturous gratulations—the speckled yellow frog with the green frog, and the green frog with the yellow—the concert of their grateful greetings being like to the solemn chanting of the Brahmans, bearing the *soma* libation at the '*atirotra* sacrifice,' in the immemorial ascription ['actio gratiarum'] of adoration and worship and praise to God in the Highest, the glory of Whose might and majesty and mercy is as the clear shining after the great rain of His strength."

Imagine any English poet from Shakespeare and Milton onward finding a "Te Deum" in the croaking—it is deep chested barking when they spring up out of the ground as the first electric droppings of the Monsoons fall on it,—of frogs and toads! The Hindus also believe that these "squat" and "ugly and venemous" creatures of God—creatures of the same elements, and modelled on the same vertebrate archetype with ourselves—bring great good luck to all who join with them in praise of the Almighty at the outburst of the Monsoons; and one of their folk-sayings founded on this faith I engraved, as coming out of its mouth, on the back of my brazen toad:—

"To all who raise their hearts in praise
For timely rain on hill and plain,
To God most High,
Who from of old
Spread out the sky
In hot or cold
Or moist or dry
For each forehold
Necessity,
To one and all who him extol,
Or churl or King, 'good Luck' I bring."

It is an interesting coincidence that Aristophanes should put into the mouth of the frogs in the comedy to which they give its name self-praise of "the harmonious strain of our hymns, and sweet-sounding song,—croaks, croaks;" but this is merely to sharpen, and envenom, the tooth of his sarcasm, and satiate the rage of his satire. Still it is an interesting coincidence; and serves to emphasise the antithesis between Western and Eastern thought on an identical subject.

THE GOVERNMENT AND THE PORT OF LONDON.

The publication of the outlines of the forthcoming Board of Trade Bill on the Port of London has proved a great relief to business circles in the

metropolis. It is now seven years ago that the department (then under Mr. C. T. Ritchie, M.P., afterwards Lord Ritchie) appointed a Royal Commission to overhaul the whole subject. Their report, dated June, 1902, unanimously recommended (i) the constitution of a Port Authority in the place of the multifarious bodies concerned with the affairs of the port, and (ii) the compulsory purchase of the docks belonging to the three dock companies. The resulting measure introduced into the House of Commons did not, however, commend itself to the interests affected. It is needless to trace here in detail the modifications and subsequent developments through which the question has since passed. Suffice it to say that the most important change is that while the creation of a consolidated Port Authority is, as before, the great and fundamental necessity, the President of the Board of Trade has now decided that the purchase of the docks by the same authority shall be optional and not obligatory.

The main points of detail, according to the notice given by the Parliamentary agent, are the appointment of a Port Authority or Commission, partly nominated and partly elected, for the constitution of committees and for the payment of salaries to the chairman, vice-chairman, and "members of the Commission." Here it will be observed that the Royal Commission, while they advocated salaries for the chairman and vice-chairman, thought that the other members should be unpaid. Probably the other salaried members will be found to be those appointed by the Government departments and the Trinity House. The limits of the port will be from Teddington Lock to a line running N.E. of Shoeburyness to Sheppey. The powers, duties, property, and authorities of the Thames Conservancy, so far as these relate to the new area, will be transferred to the Authority, including the important power of levying tonnage rates on vessels entering the port, as well as the powers, property, and privileges of the Watermen's Company, subject to giving compensation for loss of income. The Commission will be empowered to construct, equip and maintain docks, wharves, railways, &c., and to acquire existing dock undertakings and generally improve the port and levy charges. The Authority will also be empowered to deal equitably with mortgage securities and issue Port Stock, and borrow and reborrow money on mortgage. A fund will be established called the Port Fund, into which and out of which all payments will be made. The London County Council may be authorised or required to guarantee the interest on the Port Stock (which will be a Trustee Stock), while the same body and the Corporation of the City of London, or either of them, may be called upon to provide the expense of dredging the river. The remaining provisions are mainly financial, administrative and enabling.

It will be seen, then, that the principal points of divergence between the Report of the Royal Commission and the forthcoming Bill are (i) that the new Commission or Authority will be simply empowered, and not compelled, to acquire the docks, and (ii) that the Trinity House will remain independent and outside of the new body. As to the first, it seems undoubtedly better from every point of view that the new Port Commission should not be saddled with the vast load of responsibility and debt that would attach from compulsory purchase of the docks at the outset. The Port Authority at Liverpool did not acquire the docks in the Mersey till some time after its constitution, and there can be no doubt that for some space of time the new body in London will be very fully occupied with the duties laid on them, and that it would be inadvisable to overtax their energies with the super-imposition of so crushing a burden as that of controlling and administering the dock property as well. On the other hand, the non-inclusion of the lighting, buoying, and pilotage, now conducted by the Trinity House, in the list of duties of the new Commission, will probably appear questionable to many. A good deal of evidence was laid before the Royal Commission as to the great expense of London pilotage as compared with other British ports, and in most of the more important ones lighting and pilotage are entrusted to the local authority. As to the exact constitution of the new Commission and the way in which all the claims for representation have been adjusted with due respect for the interests concerned, it is impossible to speak positively until the Bill is printed.

SPANISH BEAN.

On the occasion of a recent agricultural and botanical convention in Barcelona, one of the Spanish delegates referred to the algarroba tree as the tree of the future. He based his statement upon the value of its fruit (locust beans) as a fattening and strengthening food for horses. The American Consul at Barcelona says that, after investigating the matter, he found that the algarroba, or carob tree, grows all along the Spanish coast of the Mediterranean and in the islands of Majorca and Ibiza. The beans are used as fodder for horses. The best quality is obtained in the neighbourhood of Vinaroz, and large quantities are grown in the Tortosa district. The tree grows best in dry, rocky soil. About the eighth or ninth year it begins to bear fruit, and will produce about 110 lbs. the first year. A good tree in full bearing will, on an average, produce over 600 lbs. annually, and the beans are sold at the rate of about 4s. per quintal of $89\frac{1}{2}$ lbs. The life of the carob tree is about thirty years; the only thing it has to fear is the frost, which almost invariably kills the trees. The wood of the carob tree is valueless for industrial purposes, and is sold for fuel. The beans, when used as food for horses, are strengthening, fattening, and health-giving. For use as horses' food, the beans are broken into halves or quarters and mixed with bran.

HOME INDUSTRIES.

The Cotton Position.—There is still some uncertainty as to the American cotton crop. There is no doubt that the winter frosts seriously injured the cotton harvest, but the extent of the injury remains matter of speculation. As late as a fortnight ago some American authorities predicted a crop of from $12\frac{1}{2}$ to 13 million bales, but considerably lower estimates are now accepted. Thus Mr. Larmour Neil, who has personally inspected the fields, estimates for 11,400,000 bales; Mr. Soady, another well-known expert, calculates for 11,945,000 bales; Mr. Habersham King's figures are 11,750,000 bales. Messrs. Neill, the well-known authorities on the subject, are of the opinion that the crop will not exceed 11,600,000 bales, or about two millions less than that for 1906-7. Assuming Messrs. Neill's estimates of the supply and consumption of American cotton as approximately correct, the total consumption will be roughly 12,600,000 bales, against a new crop of 11,600,000 bales, leaving a deficit of 1,000,000 bales. The reports from the Continent show few signs of contraction in demand. In France full consumption is assured for the whole of 1908, spinners being under contract for a long time ahead. It is thought that the Continent will take at least 4,200,000 bales of American cotton. The number of spindles on the Continent has increased, and although stocks are heavier than last year, the supplies from India and Central Asia will be smaller, with a consequent larger demand for the American staple. In the United Kingdom there has been a large increase in the number of spindles during the year, and several new mills are in the course of construction. It is expected that the consumption of American cotton in this country will be not less than 3,250,000 bales, or about 50,000 bales more than last year. Mr. Tattersall, a high authority, considers that nothing but a stoppage of machinery can prevent the consumption exceeding that of last year, and should the American crop be only 12,000,000 bales, there will not, he thinks, be enough raw cotton to go round. But even if the new crop is only 12,000,000 bales, or even less, it does not necessarily mean scarcity of supplies, for two reasons. The stock, visible and invisible, which was carried over from last season was very large, and the financial stringency existing both in America and Europe must cause some falling off in the consumption. Indeed, so far as America is concerned, this falling off will be very considerable; and even here it is difficult to believe that the cotton trade will altogether escape the general tendency towards contraction. The inclination is undoubtedly towards caution about entering into new obligations. In these circumstances probabilities point to the supplies of raw cotton being sufficient for the demands of the manufacturing trade. It is believed that for some time past the cotton dealers and planters have been holding back supplies, partly because of a belief that prices are to be much higher later on, and partly because of unwillingness to accept cheques or due bills.

The Cotton Dispute.—It was feared that the cotton trade wages dispute would end in the stoppage of the five spinning mills at Oldham, it being thought unlikely that the operatives would greatly modify their position, and that employers would not give way. According to this view, for some time past it has been becoming more and more difficult to deal with the operatives. The more moderate and reasonable men amongst their representatives were said to be losing their influence with their constituents, and on the other hand the employers had at last got their backs to the wall and were determined to make a firm stand against further encroachments. It was thought most probable that a strike would take place, which would be followed within a short time by a general strike or lock-out in the whole spinning trade, since this would be the only way in which the dispute could ever be brought to an end. As to the Brooklands agreement many of the more bellicose went so far as to say that they would like to see it torn up. Happily the temper indicated by these views has not been allowed to prevail, and thanks to some extent to the efforts of the President of the Board of Trade, a temporary settlement has been arrived at. On Saturday evening it was officially announced that an agreement had been arrived at between the Cotton Spinners' Association and the Amalgamated Association of Operative Cotton Spinners under which the men's notices are to be post-dated for a fortnight, and the Law Officers of the Crown will be asked to give their opinion of the interpretation of Clause 4 of the Brookland's agreement. Upon the receipt of the opinion, and in order to have time, the parties will proceed to discuss the merits of the operatives' request without prejudice, and on the clear understanding that any provisional agreements reached are subject to the condition that if the opinion when received supports the employers' contention they will be null and void, and matters will at once revert to their original position. It will be seen that a good deal remains to be done before all danger of a strike is removed, but it may be hoped that the readiness to refer the matter to the Law Officers of the Crown is a first step towards a settlement. At present neither side has been called upon to make any substantial concession.

The Metropolitan District Railway.—Additional capital being urgently required by this company to provide for the payment of temporary loans; for estimated deficits on revenue account after the current half-year; to pay for works in progress, and for necessary works of removal and improvements during the next three years; for working capital, and for contingencies the proprietors have consented to an application to Parliament for powers to carry out a plan for raising additional capital to the amount of £750,000. As all know, the cost of changing the traction from steam to electricity has been much heavier than was anticipated, and it is proposed to issue £750,000 Prior Lien Redeemable Debenture Stock

ranking next after the rent charge stocks of the company, £550,000 of the proposed stock being issued as soon as parliamentary consent has been obtained. In the twelve months ended June last, the company had a deficiency in meeting its interest charges of nearly £53,000, or of £72,000 after providing a small dividend upon the guaranteed stock. The cost of electrification, the improvements to the road, the stations, and the equipment, the low fares, the improved service of trains, and the severe competition, all have assised to tax the financial sources of the company, but it is confidently expected that within two years the net revenue will be sufficient to pay all fixed charges. With the completion of the improvements now being effected, the company will not require to spend more capital, nor will revenue expenditure be appreciably increased, whilst substantial increase in gross receipts may reasonably be anticipated.

The Hat Trade Dispute.—The acceptance by the Manufacturers' Federation of the invitation extended to them by the Workmen's Union to confer on the matter in dispute with a body of the men's representatives drawn from all the towns and districts concerned in the dispute, warrants the hope that a settlement will be brought about, difficult, as at first sight it appears, to arrive at agreement without complete submission on one side or the other, where the point in dispute is, "Is a boy or a man to work a certain machine?" A suggestion which may indicate a way out of the difficulty has been made to the effect that neither shall boys under 16 work the forty odd planking machines in dispute, as the masters stipulate, nor shall fully-paid journeymen hatters, as the men demand, but that the work shall be allotted, at a wage to be mutually agreed upon, to labourers, for whom should be created a grade in the men's union, and who should be paying members of the union. By demanding a skilled journeyman's wage for the tender of a planking machine the men are suggesting that it is skilled work, whereas they themselves admit that tending a planking machine is not skilled work, and that even a boy can, and in many cases does, do it after seeing it done once. There are other unskilled branches of the industry in which the men's union allows labourers to work, and the suggestion is that these few planking machines shall be allowed to count as one of these branches. The employers would not willingly make the concession suggested; but the tendency of legislation is against child labour, and the boy planker at present is of value for only two years, between 14 and 16. There are obvious difficulties in the way of the settlement proposed, but a long step has been taken in the decision of masters and men to meet and talk over their differences, aud it may be hoped that the conference will result in agreement.

Insurance Business with America.—The Alliance Assurance Company has decided to cease doing business in the United States. The surprising thing about this decision to many will be that it was not taken long ago, and not by one English assurance company only but by all. Probably the explanation is that the managers of these great institutions like to see a large volume of business, and shirk from the much smaller figures that must follow ceasing to do business with America. But after all assurance companies, like other industrial institutions, expect to make a reasonable profit upon their working, and this, in the case of assurance companies, is not to be got from America, as the Alliance evidently believes, under existing conditions. Fire assurance business in America is exceptionally precarious, and although some of the British assurance companies draw from one half to two-thirds of their premiums from that source this large income brings little, if any, profit. The San Francisco fire and its sequel were well calculated to alarm the most optimistic of fire managers. Clauses introduced into policies which, in the opinion of the companies concerned, as advised by high legal authority, protected them have been treated as worthless by local courts in favour of claimants, and the average loss which has fallen upon British offices in consequence has been greatly increased. It remains to be seen whether other British assurance companies will follow the example now set by the Alliance Company.

The Outlook for Trade.—Signs were not wanting before the present financial collapse in the United States that the industrial expansion in this country, which has been such a marked feature of the last three years, was coming to a close, and the collapse can only bring nearer the time when this expansion will for a time cease. The upward movement in the price of wheat and other foods is unfavourable to trade generally, for when everyone is paying more for food he has not so much to spend upon other less urgent commodities. The aggregate outturn of the crops will be smaller this year than in any year since 1901. Then the position of the iron trade has been adversely affected by the financial crisis in America, for it must mean a reduced domestic consumption in America of iron and steel, which means an increased export of these products. In a lesser degree our iron trade will have to reckon with the competition of Germany whose own internal consumptions is declining. German steel ship plates have been offered for delivery on the Clyde at much below the price of Scotch plates; and in Lancashire and the Midlands the consumption of German semi-manufactured steel is being keenly felt. Trade all over the country is still active, but there are few new orders coming in. Nobody seems to want to buy anything for forward delivery. As for shipbuilding, it is long since the outlook was less promising. Men are being paid off week by week, and many yards are at a standstill. The contracts booked last year are almost cleared off, and there are few new ones to take their place. The total of new tonnage launched this year will fall considerably short of the total of 1906, and 1908 must show a much

urther shrinkage. The cotton industry presents a better appearance, but even there many discern coming contraction. Failing trade means displaced workers and reduction in wages, certain to lead to disputes between masters and men, which in turn will intensify depression. Not for long has the trade outlook (notwithstanding still expanding exports) been less reassuring.

GENERAL NOTES.

BRITISH CONSUMPTION OF CHINA TEA.—There s a general impression that the British taste for China tea is reviving, but statistics given by Sir Alexander Hosie, Acting Commercial Attaché to His Majesty's Legation at Peking (Cd. 3727-26), do not support this view. His conclusion is, that "the consumption of China tea in the United Kingdom is steadily on the wane." Although the Customs returns give an export direct to the United Kingdom of 11,636,000 lbs. in 1906, the actual amount that went into consumption was only 5,671,121 lbs., or about 2·1 per cent. of the whole quantity of tea consumed in the United Kingdom, as compared with 2·5 per cent. in 1905, and 4·3 per cent. in 1904. In 1905, India, Ceylon, and Java sent 906,800 lbs. of tea, mostly dust, for blending with China teas, principally in the manufacture of brick and tablet teas; in 1906 they sent 8,767,200 lbs., an increase of 3,860,400 lbs., and if, as the Attaché assumes, this blend on export is classed as China tea, the increase of 4,644,601 lbs. on the whole export of tea from China is due almost entirely to this cause. There can be no dispute, says Sir Alexander Hosie, that good China tea is the best tea in the world from a hygienic point of view. It contains much less tannin than other teas, and is more suited for invalids, and those who are not favoured with good digestions. There should be no difficulty in procuring it in the United Kingdom, or even direct from China, where there are quite a number of agents who lay themselves out to supply boxes containing usually 5 and 10 catties ($6\frac{2}{3}$ and $13\frac{1}{3}$ lbs.) at moderate prices, including freight and delivery at the consumer's door. Sir Alexander Hosie will be very glad to supply names of such agents in China, if desired.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

DECEMBER 4.—"Old-age Pensions." By SIR EDWARD W. BRABROOK, C.B. SIR WILLIAM BOUSFIELD, M.A., LL.D., Member of the Council, will preside.

DECEMBER 11.—"Radio-active Phenomena." (Aldred Lecture.) By SIR WILLIAM RAMSAY, K.C.B., Ph.D., LL.D., Sc.D., F.R.S. SIR STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., Chairman of the Council, will preside.

DECEMBER 18.—"Le Rôle de la France en Afrique Occidentale." By MONSIEUR LUCIEN HUBERT, Député des Ardennes. The author will read his paper in French.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

DECEMBER 12.—"Big Game in India." By REGINALD GILBERT, F.Z.S., late o. Bombay. THE RIGHT HON. LORD HARRIS, G.C.S.I., G.C.I.E., will preside.

APPLIED ART SECTION.

Tuesday evening, at 8 o'clock:—

DECEMBER 17.—"How to Make the Most of a Museum." By LEWIS FOREMAN DAY, F.S.A. SIR ASTON WEBB, R.A., F.R.I.B.A., will preside.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

Friday evenings, at 8 o'clock:—

NOVEMBER 29.—The Hygiene of Work in Compressed Air (Diving, Caisson Work, Sub-aqueous Tunnelling, &c.). By JOHN SCOTT HALDANE, M.A., M.D., M.R.C.P. (Edin.), F.R.S. HERBERT LOUIS SAMUEL, M.P., Under-Secretary of State for the Home Department, will preside.

DECEMBER 13.—"Industrial Poisons—Lead and Phosphorus, with special reference to Lucifer Match Making." By PROFESSOR THOMAS OLIVER, M.D.

Papers for Meetings after Christmas (dates not fixed):—

"Screen-Plate Processes of Colour Photography." By C. E. KENNETH MEES, D.Sc., F.C.S.

"The Problem of Road Construction, with a View to Present and Future Requirements." By H. S. HELE-SHAW, LL.D., F.R.S., and DOUGLAS MACKENZIE.

"Recent Improvements in Decorators' Materials." By A. S. JENNINGS.

"The Underground Water Supplies of the Thames Basin." By CLAYTON BEADLE.

"Industrial Entomology: the Economic Importance of a Study of Insect Life." By F. MARTIN DUNCAN.

"Modern Dairy Practice." By LOUDON M. DOUGLAS.

"War Balloons." By AUGUSTE E. GAUDRON.

"Siam and its People." By HARRY HILLMAN.

"The Application of Science to Foundry Work." By ROBERT BUCHANAN (President, Staffordshire Iron and Steel Institute).

"The Law of Treasure Trove." By WILLIAM MARTIN, M.A., LL.D.

"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By ERNEST R. MATTHEWS, F.R.S.E., Assoc.M.Inst. C.E.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Conrad Beck, F.R.M.S., "The Theory of the Microscope." Four Lectures.

Lecture II.—December 2.—*The Correction of Simple Lenses.*—Bad quality of images formed by simple lenses—Chromatic correction—Apochromatic correction—Spherical aberration—Zonal aberration—Sine condition and Gauss surfaces—Tangent condition—Equal chromatic magnification—Summary of corrections—Correction of eye-piece.

Lecture III.—December 9.—*Influence of Diffraction.*—Explanation of diffraction—Slit—Convergent cone—Diffraction pattern or antipoint—Its influence on telescopic images—Its size—Abbé theory—Gordon's attack on Abbé theory—Relation of aperture to magnifying power—Oil immersion—Shape of and methods of reduction of size of antipoint—Limits of resolution and visibility—Special cases—Diffraction of the eye.

Lecture IV.—December 16.—*Applications of Theory.*—Best combination of eye-piece and object-glass—High power illumination—Gordon's oscillating screen—Useless aperture—Penetration for visual and photographic work—Effect of cover-glass—Substage condensers—Achromatism and aplanatism in condensers—Angle of illuminating cone—Illuminants—Monochromatic light—Wright's experiments—Critical illumination—Possible advances.

The Lectures will be illustrated by Lantern slides and Experiments.

Juvenile Lectures.

Two Lectures suitable for a Juvenile audience will be delivered on Wednesday afternoons, January 1 and 8, 1908, at 5 o'clock, by F. Martin Duncan, on "The Scientific Applications of the Cinematograph."

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 2...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Conrad Beck, "The Theory of the Microscope." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. H. Blake, "Subaqueous Operations."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. C. J. Dickenson-Gair, "The Estimation of Naphthalene in Coal Gas and in spent Oxide of Iron." 2. Dr. P. Schidrowitz and F. Kaye, "Note on the Influence of Formal on the Properties of Funtumia Elastica." 3. Dr. F. Watts and H. A. Tempany, "The Polarimetric Determination of Sucrose." 4. Dr. J. Lewkowitsch, "Niam Fat."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Arthur Fish, "British Painters and Pictures."

Tuesday, Dec. 3...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Thomas Ernest Stanton, "Experiments on Wind Pressure."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. J. H. Powrie, "The Florence Heliochromic Plate (the Warner-Powrie Process)."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Wednesday, Dec. 4...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir Edward W. Brabrook, "Old Age Pensions."

Geological, Burlington-house, W., 8 p.m. Papers by Mr. T. F. Sibley and Mr. S. S. Buckman.

Entomological, 11, Chandos-street, W., 8 p.m.

Royal Archæological Institution, 20, Hanover-square, W., 4 p.m.

Thursday, Dec. 5...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Professor J. Arthur Thomson, "Report on Alcyonaria of the Sudanese Red Sea." 2. Mr. H. C. Chadwick, "Report on the Crinoidea of the Sudanese Red Sea." 3. Professor R. J. Harvey Gibson, "Notes on Some Marine Alga from the Red Sea."

Chemical, Burlington-house. W., 8½ p.m. 1. Mr. V. H. Veley, "The Affinity Constants of Bases as determined by Methyl Orange." (Preliminary communication.) 2. Mr. F. J. Brislee, "The Velocity of Reduction of the Oxides of Lead, Cadmium, and Bismuth by Carbon Monoxide, and the Existence of the Sub-oxides of these Metals" 3. Mr. T. P. Hilditch, "The Relation between Unsaturation and Optical Activity. Part I. The Menthyl and Bornyl Esters of β-phenylpropionic, Cinnamic, and Phenylpropiolic Acids." 4. Messrs. F. B. Power and A. H. Salway, "The Constituents of Essential Oil of Nutmeg." 5. Mr. A. G. Perkin, "Methyl Ethers of some Hydroxy-Anthraquinones." 6. Messrs. A. G. Green, A. R. Davies. and H. S. Horsfall, "The Colouring Matters of the Stilbene Group. Part IV. The Action of Caustic Alkalies upon Paranitrotoluene and its Derivatives." 7. Messrs. H. O. Jones and J. R. Hill, "The Replacement of Alkyl Radicals by Methyl in Substituted Ammonium Compounds."

London Institute, Finsbury-circus, E.C., 6 p.m. Mr. F. Martin Duncan, "Forest Life."

Civil and Mechanical Engineers, Caxton-hall, Westminster, S.W., 8 p.m. Mr. A. T. Walmisley, "Retaining Walls."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. Pagg, "Automatic Cab-Signalling on Locomotives."

Friday, Dec. 6...Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. R. T. Deane, "Methods of Vaporising Liquid Fuels, used with Internal combustion Engines, as Applied to Road Vehicles."

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Annual Meeting.

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. Paul Waterhouse, "Laying-out London."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W., 8 p.m.

Journal of the Society of Arts.

No. 2,872. VOL. LVI.

FRIDAY, DECEMBER 6, 1907.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 9, 8 p.m. (Cantor Lecture.) CONRAD BECK, "The Theory of the Microscope." (Lecture III.)

WEDNESDAY, DECEMBER 11, 8 p.m. (Aldred Lecture.) SIR WILLIAM RAMSAY, K.C.B., F.R.S., "Radio-Active Phenomena."

THURSDAY, DECEMBER 12, 4.30 p.m. (Indian Section.) R. GILBERT, F.Z.S., "Big Game in India."

FRIDAY, DECEMBER 13, 8 p.m. (Shaw Lecture.) Professor THOMAS OLIVER, M.D., "Industrial Poisons—Lead and Phosphorus, with Special Reference to the Manufacture of Lucifer Matches."

Further details of the Society's Meetings will be found at the end of this number.

SHAW LECTURES.

On Friday evening, November 29th, Dr. JOHN SCOTT HALDANE, F.R.S., delivered the first Shaw Lecture on Industrial Hygiene, on "The Hygiene of Work in Compressed Air (Diving, Caisson Work, Tuunelling, &c.)." Mr. HERBERT L. SAMUEL, M.P,, Under-Secretary of State for the Home Department (Chairman), introduced the Lecturer, and gave some account of the institution of the Lectures.

The lecture will be published in a future number of the *Journal.*

CANTOR LECTURES.

Mr. CONRAD BECK, F.R.M.S., delivered the second lecture of his course on "The Theory of the Microscope," on Monday evening, 2nd inst.

The lectures will be published in the *Journal* during the Christmas recess.

APPLIED ART SECTION COMMITTEE.

A meeting of the Committee of the Applied Art Section was held on Tuesday afternoon, 3rd inst. Present: Sir William Bousfield, M.A., LL.D. (in the chair), Alan S. Cole, C.B., Lewis F. Day, F.S.A., Gerald C. Horsley, F.R.I.B.A., Halsey Ricardo, F.R.I.B.A., Hugh Stannus, F.R.I.B.A., H. H. Statham, F.R.I.B.A., Sir Thomas Wardle, with Henry B. Wheatley, Secretary of the Section.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

Wednesday, December 4th, 1907; SIR WILLIAM BOUSFIELD, M.A., LL.D., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Archibald, Andrew Manley, F.R.G.S., 7, Terrapin-road, Balham, S.W.

Bailward, Colonel A. C., 1, Princes-mansions, Victoria-street, S.W.

Brannam, Charles H., Litchdon-street, Barnstaple, Devonshire.

Elder, Arthur S. W., Assoc.M.Inst.C.E., Newbold, Edenbridge, Kent.

Foster, Harold Duncan, 20, Norfolk-road, Regent's park, N.W.

Graham, John Campbell, M.A., M.D., 69, Kensington-gardens-square, W., and Binjey, Deli, Sumatra, Netherlands India.

Gray, Herbert Charles, A.M.I.E.E., Telephone-house, Victoria-embankment, E.C.

Henri, Arthur, 6, Hopton-road, Streatham, S.W.

Morrow, Robert Alexander, 6, Landridge-road, Fulham-park, S.W.

Taylor, Miss Laura E., 64, Emanuel-road, Balham, S.W.

Vallat, Henry Howard, 26, Stonor-road, West Kensington, W.

Wilson, Joseph, Messrs. W. Crowder and Co., Limited, Bombay, India.

The following candidates were balloted for and duly elected members of the Society:—

Abrahams, Ernest Goldsmid, F.S.S., The Chesnuts, Brondesbury-park, N.W.

Almenräder, Gustav Hermann, Violeta, Manor-road, High Barnet, Herts.

Ampthill, Lord, G.C.S.I., G.C.I.E., Milton Ernest-hall, Bedford.

Armstrong, Major Samuel Treat, M.D., Ph.D., 144, East 37th Street, New York City, U.S.A.

Athim, Samuel, Assoc.M.Inst.C.E., Executive Engineer, Public Works Department, Dhukwan P.O., *viâ* Babina (G.I.P. Railway), India.

Bampfylde, C. A., Larethan, Bodmin, Cornwall.

Barber, Frank Peto, Claremont-house, Hooley-green, Halifax.

Barlass, Thomas, M.R.San.I., 45, College-street, S.E.

Batsford, Herbert, 94, High Holborn, W.C., and 35, Springfield-road, N.W.

Bell, Henry Purdon, M.Inst.C.E., Kent Canal, Campbellford, Ontario, Canada.

Bennett, William Hart, Government-house, Nassau, Bahamas, and Royal Societies Club, St. James's-street, S.W.

Benton, John, C.I.E., M.Inst.C.E., Belvedere, Simla, Punjab, India.

Buchanan, Robert, The Hawthorns, Sutton-road, Walsall.

Cohen, Abner, J.P., Krugersdorp, Transvaal, South Africa.

Copland, Fitz-John Henry, J.P., Mount Rodney Estate, St. Patrick's, Grenada, British West Indies.

Das, Madhu Sudan, C.I.E., Katak, India.

Das, Miss Shaila Bala, care of M. S. Das, C.I.E., Katak, India.

Davies, C. Gilbert, Messrs. Davies and Thomas, The Bund, Shanghai, China.

Deo, Rajendra Narayan Bhanja, Raja of Kanika, Katak, India.

Dukes, Thomas William, Vryheid, Natal, South Africa.

Fabarius, Erich, Messrs. Knoop and Fabarius, Bremen, Germany.

Ford, Richard Thomas, 42, Dyne-road, Brondesbury, N.W.

Frame, David Bruce, Napier, New Zealand.

Galton, Lady Marianne Douglas, Himbleton Manor, Droitwich, and 12, Chester-street, S.W.

Gladstone, Arthur Steuart, 78, Onslow-gardens, S.W.

Gupta, Jogendra Nath Das, B.A., Hooghly College, Chinsurah, Bengal, India.

Heather, Henry James Shedlock, B.A., M.Inst.C.E., Messrs. H. Eckstein and Co., P.O. Box 149, Johannesburg, Transvaal, S. Africa.

Holton, Henry D., A.M., M.D., State Board of Health, Brattleboro, Vermont, U.S.A.

Hossein, Md. Mufazzal, Camp Golaghat, Assam, India.

Hunt, Henry J., The Priory, Wimbledon-common, S.W.

Hurd, Milner, A.M.I.Mech.E., Laud-chambers, Reading.

Iwai, Tatsumi, Civil Affairs Bureau, Taihoku, Formosa, Japan.

Johnson, Alfred Latunde, Central Province, Warri, Southern Nigeria.

Keeley, David Herbert, Department of Public Works, Ottawa, Ontario, Canada.

Kermode, John Jonathan, M.I.Mech.E., Imperial-chambers, 62, Dale-street, Liverpool.

Khoo Chong Lye, Raub, Pahang, Federated Malay States

Knocker, Fred W., Perak State Museum, Taiping, Federated Malay States.

Kyaw, Moung Ba, 12A, Mecklenburgh-square, W.C.

Lake, Charles Sidney, A.M.I.Mech.E., 5, Falkland-avenue, Church-end, Finchley, N.

Lim Cheng Law, Sungei Pinang, Penang, Straits Settlements.

McGaw, Andrew Kidd, Burnie, Tasmania.

McGhee, Miss Evelyn P., 82, Porchester-terrace, W.

Marshall, Archibald McLean, Crogen, Corwen, North Wales.

Miles, Roslyn, 79, Sterndale-road, West Kensington, W.

Milne, Oswald P., 16, Great James-street, Bedford-row, W.C.

Otagiri, Tadawo, 15, West Bolton-gardens, S.W.

Pearson, Mrs. Kate Hyde, 23, Palace-street, S.W.

Peddar, Sydney Hampden, 6, Kensington Palace-gardens, W.

Phillips, Mrs. Lionel, Tylney Hall, Winchfield, Hants.

Pitt, Colonel William, R.E., 78 Eccleston-square, S.W.

Plante, Stanley Gedge, Assoc.M.Inst.C.E., 24, Worple road, Wimbledon, S.W.

Pollock, Sir Frederick, Bart., D.C.L., M.A., LL.D., 21, Hyde-park-place, W.

Richert, J., 44, Cambridge-street, Hyde-park-square, W.

Ritch, L. W., 28, Queen Anne's-chambers, Broadway, Westminster, S.W.

Robertson, John, A.C.P., The School-house, Strachur, Greenock, N.B.

Saito, Vice-Admiral Baron, I.J.N., Navy Department, Tokyo, Japan.

Sakō, T., President, Japan Sugar Company, Sunamura, Minami Kalsushika Gori, Tokyo, Japan.

Setti, S. Venkata Subba, B.A., Chikmagalur, Mysore Province, India.

Silberstein, Willy, 27, Clement's-lane, E.C.

Smithers, F. O., 171, Adelaide-road, South Hampstead, N.W.

Smythe, Captain Alan, Milford-lodge, Craven Arms, Shropshire.

Stackhouse, J. Foster, 95, High-street West, Sunderland.

Stewart, Cecil G. G., 1, Clarendon-street, Warwick-square, S.W.
Swan, John Sidney, Wellington, New Zealand.
Talbot, P. A., B.A. (Oxon), The Cottage, Abbots Morton, Worcestershire.
Tucker, William, Regina, Saskatchewan, Canada.
Walford, Leopold H. G., 48, Cornhill, E.C., and 14, Park-place-villas, W.
Walpole, E. Horace, 89, New Bond-street, W.
Waring, Alfred, M.B., M.R.C.S., L.R.C.P., 7, East Circus-street, Nottingham.
Waring, Captain Antony Henry, M.R.C.S., Lahore Encampment, Punjab, India.
Waring, Henry Robert, M.Inst.C.E., 127, San Miguel, Palma de Mallorca, Spain.
White, Frank Faulder, F.R.C.S., Coventry.
Worsley, Harold, Moor Plantation, Ibadan, Lagos, West Africa.

The paper read was—

OLD-AGE PENSIONS.

By Sir Edward W. Brabrook, C.B.

In this paper I do not propose to discuss whether old-age pensions should be granted either by the Government or with the aid of the Government. There are those who think that neither the one nor the other is within the legitimate province of Government, and I have some sympathy with their view; but as the Government has declared that it is within its province, as the Chancellor of the Exchequer has intimated his intention of appropriating next year a sum of money towards the provision of old-age pensions, and the House of Commons has in principle accepted his proposal, and as political parties seem to be pledging themselves past recall to legislation for the promotion of some scheme for the assistance of old age, I propose to assume for the purpose of this paper that the demand that has been made for old-age pensions is to be met, and that State provision or State aid in some form will be invoked to procure them.

On this assumption, it becomes a matter of pressing necessity to inquire and to determine the best form in which this provision or aid can be granted, even if the expression "best" be taken to mean only "open to least objection." I do not, therefore, propose to discuss the several schemes upon those high economic grounds which have been so ably set forth by my friend, Professor Chapman, in his recent paper read before the Royal Economic Society, but as a practical matter, dealing with the requirements and the resources of the present day. That, however, is the only limitation I propose to the discussion. I am aware that important members of the Government have said they would not assent to a scheme of pensions which required any specific contribution from the beneficiaries towards the cost of their own pensions. I do not hold myself bound by this statement to refrain from proposing a scheme which makes that requirement, and I do not think this meeting is bound to refrain from discussing any such scheme. I go further, and say that those members of the Government are themselves not precluded by those statements from considering the arguments we may bring forward, and that if we are able to show conclusively that such a contributory scheme is at once the most equitable, the easiest to administer, and the least open to abuse of any scheme that can be devised, they will be quite at liberty to adopt that scheme, nay, more, it will be their duty to the public to adopt it, notwithstanding those premature expressions of an opinion founded, no doubt, on the information then before them, but liable, like all human opinions, to reversal upon more complete information.

Glancing for a moment at the history of the ventilation of this question, it was in November, 1878, that the late Rev. Canon Blackley published in the *Nineteenth Century* an article on "National Insurance." In that and subsequent publications, he advocated a scheme of compulsory contribution for old-age pensions. On July 14, 1880, he delivered an eloquent address to this Society on the subject, which was followed by an interesting discussion. In the sessions of 1885, 1886, and 1887, committees of the House of Commons were appointed to inquire into the best system of national provident insurance against pauperism. Canon Blackley was the first witness before the committee of 1885, the last witness before that of 1886, and the principal witness before that of 1887. The committee of 1887 finally reported against his scheme, and I think rightly, for reasons that I will presently submit to your consideration; but his principle that thrift and national insurance are a security against pauperism was a true one, and I am glad to observe that his widow, Mrs. M. J. J. Blackley, has recently reprinted his essays, with a memoir of her excellent husband.

I hope that this interesting pamphlet, due to the pious care of a lady 73 years of age, will have a wide circulation; for the principles

it asserts are sound, though Canon Blackley's method of solving the difficulty appears to me to be open to grave objection. He stated his proposal in the following terms:—"I propose that every individual in the nation shall be liable by law, after reaching the age of 18 years, to contribute either in one sum or by instalments £10 or thereabouts to a National Sick and Pension Benefit Society, which would secure to him or her when prevented by sickness from earning his or her usual wages a weekly sum of 8s. a week until 70 years of age, and after 70 years of age a cessation of the sick pay, but a pension for life of 4s. a week." My first objection to this would be its introduction of compulsion. Even if this were not open to objection upon principle, the difficulty of applying it would constitute a strong objection to it in practice. Every person, whether he was in a position in life to require the old-age pension or not, was to be compelled to purchase it, by the payment of £10, either in one sum or by instalments, after the age of 18 years. At that age many are not earning anything; and the compulsion would have to be applied to the parents or guardians of such young men. The earnings of others are wholly insufficient to enable them to pay the large sum demanded, either in one sum or by instalments.

But compulsory insurance is objectionable upon principle. Every man is the best judge of his own necessities and his own resources to meet them, and it is not equitable that the Legislature should step in and say that, whether or not you have provided for these necessities out of your own resources in a manner which is satisfactory to you, you shall provide for what we consider is necessary for you in the manner which is satisfactory to us, and we shall tax those resources still further in making you do so. It is no part of the legitimate functions of a Government to compel people to be provident in its own way, or to dictate to people what method of making provision for their future they should adopt.

The second objection to Canon Blackley's plan was, his mixing up sickness assurance with the assurance of an old-age pension. An asssurance of two distinct benefits, the conditions of which are different, should be granted only in consideration of separate premiums, and that observation is especially applicable to the two benefits in question. While a deferred annuity, which is the technical term for an old-age pension, depends upon one contingency only — that of the person surviving to the age fixed for the annuity to begin, in other words, upon what are called the laws of mortality, an assurance of sick pay depends upon a number of contingencies. The Government may well undertake the business of assuring deferred annuities, which requires only the regular investment of the contributions and re-investment of the interest upon them until the age fixed for the annuity to begin, and then the payment out of that annuity: but in undertaking the business of sick pay insurance, it is at a great disadvantage, as compared with the ordinary friendly society, where the members are known to each other.

The fact is, that Canon Blackley had formed a very pessimistic view of the condition and prospects of the friendly society movement. He preached a sermon in Westminster Abbey on 28th Sept. 1879, which is reprinted in the pamphlet I have referred to, and took for his text that fine sarcasm of the prophet Haggai, "He that earneth wages, earneth wages to put it into a bag with holes." By a national insurance against sickness, he would have taken away from the friendly societies their best source of income, arising from the business which they are most competent to manage, and would have left to them only such surplus insurance beyond the small amount of 8s. a week which he proposed as their members might desire to have. The result would have been that the interest of each member in his friendly society would have become much smaller than it is now, and the evils which arise in societies which insure burial money only, from the smallness of the members' interests would have been extended to the sick societies, and thus the better societies would be levelled down to the same condition as the worse. This in itself would be so deplorable a result, that upon that ground alone his scheme ought not to be adopted. I myself do not share Canon Blackley's pessimistic views. In relation to friendly societies, I am an optimist, and I think with good reason; though I am convinced that the agitation of this question of old-age pensions has been one of the causes that have in recent years retarded their progress.

Thirdly, Canon Blackley's scheme was actuarially unsound. His proposed contribution would not have been sufficient to procure the sick pay and the annuity, even under normal conditions; and if, as appears probable, the existence of a national sickness insurance fund

would have altered those conditions for the worse, it would have been so much the more insufficient. To this he might no doubt have answered that he had not pledged himself to a precise figure, he had spoken only of £10 "or thereabouts;" but it is evident that the amount of the contribution is a material element of such a scheme, and its actuarial soundness ought to have been tested and established before it was promulgated.

For these reasons, Canon Blackley's "compulsory, contributory, and non-discriminatory" plan is not, it appears to me, to be recommended; though I strongly commend to your consideration much of the weighty matter contained in his book.

More recently, the Congress of Trade Unions has declared that no plan will be satisfactory to them which is not non-contributory as well as non-discriminatory. In other words, they have adopted the proposal originally made by the Right Hon. Charles Booth, that a State pension should be granted to every individual of the community, without any other contribution by him than his contribution to the taxation by which the State pension fund is to be raised; for we must always bear in mind that the State is not the owner of any gold mine from which unlimited supplies of money can be extracted, but is absolutely devoid of any property of its own, and can only raise money for any purpose by means of taxation. In some way, therefore, these pensions must be raised by "contribution," and every scheme is really a "contributory" scheme.

If that is so, why should pensions be universal? Is it supposed that people entertain some sentimental objection to accept a pension when an equal pension is not granted to everybody else? There must be at one end of the scale a number of persons to whom a pension of the small amount proposed would be of no use; and at the other end of the scale a number of persons to whom such a pension would be a real injury. Why should the State insist upon paying to the former class a pension which they do not want, and to the latter class a pension which they will certainly misuse? And how is the State to raise the money to pay all these pensions? The return published by the Local Government Board shows that the estimated number of persons aged 65 and upwards in the middle of 1907 is 2,116,247. A minimum pension of 5s. and a maximum of 7s., or an average of 6s. to each of these, with 3 per cent. added for expenses, would cost more than £34,000,000 a year.

How is that £34,000,000 to be raised? A Chancellor of the Exchequer who has to provide for a definite liability of fixed amount such as this cannot rely upon indirect taxation, for the proceeds of indirect taxation are fluctuating and uncertain. He must therefore have a scheme of direct taxation to fall back upon, and that must form the mainstay of his finance. What form of direct taxation could produce £34,000,000 a year without serious interference with economic conditions? It has been said that a nation which could spend more than £250,000,000 on the South African war could easily raise £34,000,000 a year. Without inquiring what have been the financial consequences to the nation of that large expenditure of its capital, we may point out that an annual expenditure of £34,000,000 a year represents a capital of more than £1,000,000,000, or more than four times the amount of capital expended upon the South African war.

The answer of the Trades Unionists has been—"Oh, but it will not cost nearly £34,000,000 a year; for a great number of people will not claim it." Stay a moment—was it not to be non-discriminatory? the absolute right of everybody to have his or her pension? Why then should any person not claim it? If I am entitled of right to 5s. a week, why should the circumstance that I am a millionaire lead me to waive that right? A man does not become a millionaire by the practice of not enforcing his rights, however small they may be. If any considerable number of persons are induced to refrain from claiming the pensions to which they are entitled, it must be for some reason or other: either you make the pensions difficult for them to obtain; or you make them think it is not to their credit to claim the pensions; or you create a public opinion that will impose some social penalty or disability upon the persons who do claim the pensions.

These constitute the worst kind of discrimination. To so arrange the machinery for claiming a pension that nothing but dire necessity will induce a man to go through the trouble and the ignominy of doing so might be good policy in the eyes of some keepers of the public purse; but it is a tyrannical, not to say a most dishonest policy. To tell a man with one breath that he is entitled of right to a pension and with the next that he will be a mean fellow if he claims it, is to introduce into the matter not merely an element of inconsistency but one of sordidness.

To coerce a man by social penalties to abstain from claiming that to which you admit he has a right is again an unendurable tyranny. But in any case it is discrimination; and this argument therefore disposes of the non-discriminatory element in the plan. If the plan is to be universal and non-contributory, and really non-discriminatory, then the Chancellor of the Exchequer must find out some means of providing £34,000,000 a year, and more as time goes on.

As the Chancellor of the Fxchequer says he has only 2¼ millions a year at his disposal, I might leave the matter there, and wait for the further discussion of it until some Chancellor of the Exchequer arrives who will say he has 34 millions a year at his disposal; but there is the risk that the Chancellor of the Exchequer may adopt some plan for the application of that 2¼ millions which will serve as a mere vaulting-board from which the advocates of the 34 millions scheme may push him off into the full current of their extravagance.

Nothing can be more dangerous, I venture to think, than for the Chancellor of the Exchequer to apply his 2¼ millions to the provision of a small pension at an advanced age, with the necessary consequence that each year there would be an agitation for the application of more public money to increase the amount of pension and bring down the age earlier, until some future Chancellor of the Exchequer finds himself saddled with the whole burden.

As, therefore, Canon Blackley's contributory and non-discriminatory system, and Mr. Booth's non-contributory and non-discriminatory system are both open to serious objection, we have to look to the various discriminatory proposals that have been made for the solution of our difficulty; and we will take first the non-contributory, discriminatory proposals. As to these, it has been said, why not adopt plans such as have been successfully worked in New Zealand, New South Wales, Victoria, and other colonies? These plans involve an inquiry into the means and into the merits of applicants for pensions. A recent report of a Royal Commission appointed by the Governor-General of the Commonwealth of Australia furnishes us with much information as to their working; and I contributed to the *Spectator* and afterwards to a little book on "The Manufacture of Paupers," some observations on that report, from which I ask leave to make a few quotations.

I may state that the Commission did in the result unanimously recommend a scheme of old-age pensions for the whole Commonwealth. They reported that in New South Wales the maximum pension is 10s. per week, reducible in the case of married people to 7s. 6d. per week, and also reducible by the amount of all independent income over those sums, and by one-fifteenth of the capital value of property exceeding £50. In Victoria the maximum pension is 8s. per week, reducible by the amount of all independent income over 2s. per week, and by 6d. per week for every £10 capital value of property exceeding £75. In the Dominion of New Zealand the pension is 10s. per week, reducible by all independent income exceeding £34 a year, and by one-tenth of the capital value of property exceeding £150. It will be seen from this that, although there are differences of detail, the broad lines are the same, and that each scheme virtually comprises the same classes of persons.

When, however, we turn to the results shown in the evidence of the Government statist of Victoria, we find a strange divergence. The pensioners in Victoria are only 17 per cent. of the population above 65 years of age, while those in New South Wales are nearly 44 per cent., and those in New Zealand something less. This shows in a striking manner the effect of different principles of administration. In New South Wales fraudulent claims have been made and allowed; children in good circumstances have been relieved of the obligation of supporting their parents; even a husband established his claim to a pension upon the ground that he had previously settled all his property upon his wife. In Victoria, on the contrary, as the Agent-General for New South Wales complains, the aim of the administration has been to limit the number of pensions granted.

Notwithstanding the apparently undue liberality of New South Wales, there has been set up in that colony as well as in Victoria, a costly, frequently inconclusive, and always irritating, system of inquiry into the claims for pensions. This is, indeed, one of the most undesirable features of all discriminatory schemes, except the one that I am here to advocate, as it would be of the trade unionists' scheme, if that were to become in effect a discriminatory one in the way I have indicated. I do not propose in this connection to discuss the evidence given before the Commissioners as to the indirect evils which have followed the adoption of these schemes by the various colonies in the discouragement of thrift and otherwise, as that bears rather on the general

question whether there should be an old-age pension scheme at all, which for the present purpose I am not here to argue.

A non-contributory and discriminatory scheme was, however, devised by a Select Committee of the House of Commons in 1899. They recommended the grant of a pension of not less than 5s. nor more than 7s. a week to every person who possessed the following qualifications:—

1. British nationality.

2. Attainment of the age of 65.

3. Absence of conviction for any serious offence between the ages of 45 and 65.

4. Non-receipt of poor-law relief (other than medical relief) during the 20 years preceding the application for a pension, unless in circnmstances of a wholly exceptional character.

5. Residence within a given district.

6. Non-possession of an income from any source of more than 10s. a week.

7. Proved industry or proved exercise of reasonable providence by some definite mode of thrift.

The committee were not able to say how much their scheme would cost; and another Committee was appointed by the Local Government Board to find that out. According to the estimate of that committee the cost would be £10,780,000; but the committee did not fail to show that there are unknown quantities which must affect that estimate so as to render it insufficient. Persons whose incomes are over the border line of ten shillings a week might be tempted to conceal the facts or even to assign away some of their means; a person of 65 earning a little over the ten shillings might be tempted to agree with his employers for a reduction of wages that would qualify him for the pension; children contributing towards the support of aged parents, relatives, or past employers, or charitable people contributing to the support of other aged persons, might be tempted in like manner to transfer their burden to the Government. Under every head of the qualifications for pension suggested by the Select Committee abuse might arise, and the aggregate cost of the pensions be increased.

As, however, the Chancellor of the Exchequer has only $2\frac{1}{4}$ millions at his disposal, a scheme which will cost about 11 millions is not yet within the range of practical politics.

I do not propose to comment at length on foreign systems, mainly for the reason that the pensions which they contemplate are relatively so small that they are of little use as precedents for an English system. The French pension plan was only enacted last year, and came into operation during the present year; it is therefore too early to enquire into its working. It has some curious features: one is that an extra pension is given to any person who has brought up a child from birth to the age of 16, whether or not that child is his or her own or is related to him or her, or is legitimate; another is that local authorities are at liberty to grant pensions on a higher scale than that provided by the Government, but are in that case required to provide these pensions out of their own revenues.

The German system involves a contribution of approximately one-third of the cost by the employer, one-third by the workman, and something less than one-third by the Government. Its conditions are such that a similar system could not be adopted in England without the creation of new and costly machinery. The Danish plan is one of granting a pension by selection among the most deserving of the necessitous persons.

I now turn to the proposal which appears to me to be the only practicable one, and which is contributory and discriminatory, but in a widely different sense from that in which the latter word has been used before, for in this case the discrimination is exercised by the person who is to be entitled to the pension and not by any other person, whether officer of state, guardian of the poor, inspector of police, or anything else. This proposal leaves every man and woman absolutely free to accept or reject the offer of Government assistance in enabling him to provide for himself, at once securely and cheaply, just such an old-age pension as he himself thinks he wants; and that especially commends the proposal to my mind.

It was made public in a letter addressed to *The Times* on September 3rd by Lord Avebury, Sir Alfred Lyall, Sir Arthur Clay, Sir William Chance, Mr. Bailward, Mr. Mackay, and myself; and as I cannot presume that all here have read it, I must ask leave briefly to repeat its main features. It is founded on the precedent of the system established as long ago as the year 1819 by an Act of the 59th year of George III., and still in force under an Act of 1896, the 59th year of Queen Victoria. Under these statutes the Government receives money from friendly societies for the purpose of investment upon the condition that it guarantees the society a fixed rate of interest so long as the person lives whose life has been

insured by the society in respect of the money so invested. Our proposal is simply to extend that plan to payments made for the purpose of insuring an old-age pension, and to accumulate such payments during the whole continuance of such insurance at a rate of interest exceeding that earned by the Government on the money.

This arrangement would render necessary a vote by Parliament each year of the amount of that extra interest, but as the claim would arise out of an express contract with the purchasers of the pensions, and would be for the excellent purpose of assisting them to obtain those pensions and rendering such pensions absolutely secure, there need be no fear that Parliament would ever hesitate to vote the necessary amount. It would not now, or for many years to come, exceed the $2\frac{1}{4}$ millions of money which the Chancellor of the Exchequer proposes to devote to this purpose, for if the extra interest were 1 per cent., it would not call for $2\frac{1}{4}$ millions until a capital fund of 225 millions had been raised. This small contribution by Parliament would, however, be a substantial gain to the purchaser of the annuity. Take, for example, the case of a man who, beginning at the age of 20, contributes £1 a year for a pension to begin when he is of the age of 65.

Now £1 a year is only a little over 4d. a week, or two-thirds of a penny a day—one-third of the cost of a pint of beer a day. Yet if the Government earned only 3 per cent. on its investments, and Parliament voted nothing, that £1 would ensure a pension of 8s. a week after 65. If Parliament voted 1 per cent. extra, raising the rate of interest to 4 per cent., the pension would be 11s. 4d. a week. If the pension were not to begin until he was 70 years of age, it would be at 3 per cent. 16s. 2d. a week, and at 4 per cent. £1 3s. 8d. a week. So that the proposed grant of additional interest by Parliament is a substantial benefit to the pensioners, and is quite equal in point of fact to the contribution which the German Government makes to those who subscribe under its much less liberal scheme.

Although we refer to £1 a year as an illustration of the manner in which our proposal would work, it is not intended that there should be any fixed or periodical contribution exacted from subscribers, but we would allow every man or woman to pay what sum he thinks fit, whenever he can afford it, and to obtain the pension corresponding to the sum which he pays at whatever age he may fix for himself. Again, although this scheme would be very convenient to the friendly societies, enabling them to act as agents for the Government in collecting contributions and distributing pensions, it is in no way restricted to members of those societies. Other working men's societies. such as trades unions, co-operative societies, and working men's clubs, might collect contributions and distribute pensions in the like manner. Indeed, no person need belong to any society in order to obtain the benefit, as any person, whether a member of a society or not, might buy the pension direct from the Government. No doubt some limitation would have to be devised that would prevent rich men, or relatively rich men, from availing themselves of the Parliamentary grant as a speculation for their personal profit. The limitation we have suggested is £2 12s. a year, or 1s. a week, but that is a matter of detail which is quite open to further consideration. Provision might be made to enable a person receiving a small legacy or other windfall to pay for a few years in advance, and thus apply a sum to the best advantage, which would probably otherwise be wasted. It has been an objection to some other contributory schemes in which the co-operation of the friendly societies is an element, that Government would become responsible for the solvency and good management of these societies, a responsibility of which it has not the capacity to discharge itself, but no such responsibility would be incurred under this plan, as these societies would be mere agents.

The other advantages of this plan may be summed up thus:—It is reasonable, it requires every member of the community to satisfy his or her own mind that the pension is worth to him or her the small sacrifice that would have to be made to secure it; it follows a precedent that has been well tried and been found to be successful; it is safe, because it is based upon careful actuarial calculations; it is capable of indefinite extension; employers may insure pensions for those they employ; parents for their children; charitable persons for those they wish to help; it is economical, for though, as we have seen, the Government supplemental interest is equivalent to a substantial increase of the pension, it can be obtained by a moderate Parliamentary grant; it benefits the right persons, viz., those who show a disposition to help themselves, and who by their thrift have shown themselves worthy of the pension they claim, and quite unlikely to misuse it.

To these may be added that it has less risk of fraud than any other plan, since it would be to no man's interest to understate his age, and so postpone the time of entering upon his pension, or to overstate it, and so increase the amount of his contribution. I do not propose to enter into questions of mere machinery, which will afterwards have to be worked out in detail by experts, but as an illustration of the simplicity with which it might be worked, I may indicate the plan which is in my mind. A table would have to be prepared, showing for each unit invested at each age the fractional pension which that unit would procure at a future age. The local societies would collect the money until it amounted to an even pound, and would then pay it over to the Government, receiving in exchange a card specifying the amount of fractional pension as shown by the table which had been purchased by that pound. For example, the single payment of £1 by a man aged 20, would buy him, at 3 per cent., a pension of £1 19s. 4d. a year, or 9d. a week, after attaining the age of 70; and at 4 per cent. a pension of £3 7s. 4d. a year, or more than 1s. 3d. a week. If, therefore, he elected to begin his pension at 70, his card would specify the pension of 1s. 3d. a week as having been already earned by the single payment of that £1. When he had saved another £1, he could bring or send it with his card to the pension office, and have his equivalent pension at his then age for that £1 added to the amount marked on the card, thus increasing his pension by each payment made. On attaining the age of 70, all he would have to do would be to produce his card and receive the aggregate of the weekly sums specified thereon. To that he would have an absolute right, having paid the purchase money, and only received from the Government assistance by way of additional interest. If the contributor wished his pension to begin at 65, his single payment of £1 would earn him 19s. 10d. a year at 3 per cent., or £1 12s. 9d. at 4 per cent., for the remainder of his life.

Our proposal is, of course, directed solely to the purpose of assisting every person to provide for himself an old-age pension at the cheapest possible rate. That was made clear in our original letter to *The Times*, in which we said that "it would be right to enact that no portion of the money deposited with the Government should be withdrawn, except for the purpose of the actual payment of pensions;" and further, that "there must be no question of forfeiture," that is, of depriving a contributor of the benefit of his past payments if he fails to continue paying, as is done by friendly societies and assurance companies; but that "every sum of money that has been actually deposited with the Government must produce at the pensionable age the pension that is its calculated equivalent." The contributions are made for the sole purpose of providing pensions for old age.

It has been made an objection to our proposals that we do not provide also a sum at death, and that a man who does not live to the pensionable age will get nothing. We have been asked, do his contributions lapse to the State? The answer is, No: they are applied to the purpose for which he paid them—the provision of an old-age pension. The whole of them is required for and absorbed by that provision. There is nothing left to pay a sum at death. If he wishes to assure a sum at death he must pay for that, either to a friendly society or an assurance company, or he may accumulate it for himself by putting money in the savings bank, or he may insure it with the Government, if the Government like to undertake that business also; but he cannot have it out of the money devoted to the special purpose of buying an old-age pension. You cannot eat your cake and have it too. Moreover, if there were any validity in this objection, it applies to all schemes alike, for in none is a sum at death provided for.

Then we have been told that our proposals are a lottery. They are the very reverse. A lottery makes one man rich by chance at the cost of the rest. An insurance relieves all alike from the risk of being plunged by chance into poverty. Lotteries and insurance have nothing more in common than have theft and thrift.

Then we have been told that members of friendly societies can insure old-age pensions for themselves on as good terms as we offer, and can make 4 per cent. for their money without troubling the Government. If that is so, we have only to congratulate them. No one will be under any compulsion to accept the aid of the Government, and those who are able to dispense with that aid deserve credit for their independence. But is it really so: can friendly societies in general count upon a continuance during a long course of years of earning 4 per cent. on their investments without any loss of interest or of capital? I am much inclined to think that the experience of societies will show that it is better worth their while to accept the

guarantee by Government with the sanction of Parliament of the security of their money, and of an equal rate of interest during the whole continuance of the lives of their members, than to insure the pensions themselves.

Two more objections to our proposal may be mentioned, though they neutralise each other. It is said that few persons will avail themselves of it. That would only show that few persons are really convinced that they need an old-age pension. It is also said that it will be so attractive that it will induce people to buy pensions who could invest their money to better advantage, the answer to which is that each one must judge for himself.

As to those who earn hardly enough to live upon in the present, much less to save for the future, even for them our proposal offers some hope. Into most lives there comes at one time or other a gleam of sunshine, and our plan leaves every man free to avail himself of any such happy chance of securing something for the future. But the real remedy for their case is an increase of wages. No man ought to be called upon to take out of himself the value of a day's work without receiving in return the equivalent of that which he has given up, and that includes not merely maintenance now, but the means of securing a maintenance when working days are over. That, however, raises a large economic and sociological question, which we cannot now discuss.

Then there is the point that some years must pass before pensions begin actually to be payable. As to this, we must see how much of the Chancellor of the Exchequer's $2\frac{1}{4}$ millions is left after paying for surplus interest, and how that can best be applied in addition to the contributions of those who at the starting of the plan are of the more advanced ages. We have indicated a method by which something of that kind could be arranged. Existing pension funds might also be taken over.

Admitting, therefore, all the difficulties that surround the question, "we respectfully submit that the plan we have sketched is less open to objection than any other, inasmuch as it preserves the obligation of the individual to contribute towards a provision for his old age and encourages thrift, which we believe to be a wholesome and necessary discipline for the members of every economic society." I am still firmly convinced of the truth of what I wrote in 1890, "that there is no other way of providing for old age than by thrift, self-denial, and forethought in youth." The proposals we have made go directly to encourage and stimulate these virtues, and that result is well worth the small expenditure of public money which is required to carry them into effect. That expenditure will, indeed, be productive expenditure in the best sense of the word.

DISCUSSION.

The Chairman (Sir William Bousfield), in opening the discussion, said that Sir Edward had made a very important contribution towards a discussion which was absolutely inevitable at the present time. It would be very unlike Englishmen to pass a great national scheme affecting their finances and social position without seeing where they were going. The subject was most difficult, and one which was of the first importance economically—economical not only as relating to finance, but as to its effect upon the society in which one lived. Everybody was anxious that it should not be said of the proposal for old-age pensions what President Roosevelt had said of Socialism, that it was "an attempt to put laziness, thriftlessness, and inefficiency on a par with industry, thrift, and efficiency." Sir Edward's paper was a conservative one, in the respect that it aimed at aiding those forces in society which were the most valuable, and which had done most to promote the well-being of the great industrial classes in their attempt to provide what was required by the ordinary working man and his family. If Sir Edward's proposition were accepted, it would mean that friendly societies would be strengthened, that they would not be pushed out of the work which they were endeavouring to do, but helped in it. He (the Chairman) was very sorry to hear from Sir Edward that already the agitation for old-age pensions had had some effect in diminishing their work and the numbers of those who were joining the societies. The deviser of a scheme such as the author's was under a certain disadvantage. Sir Edward had put forward certain propositions most clearly and comprehensively, but in putting them forward he was in the position of one who had given examples which might specially be criticised. In the great deal of talk which had been heard about old-age pensions, no attempts had been made to deal with the question of the details of the scheme; it was assumed that it was a thing which was wanted, but it was impossible to criticise a nebulous and vague statement of a wish. It was only when anyone came into the open, as Sir Edward had done, and gave details that it was possible really to criticise any proposition. He himself very largely agreed with the paper, but he did not see why, if a scheme was formed and carried into effect, compulsory payment on the part of the person who would receive a pension should not be introduced. Compulsory payment was the essence of the German system, and he

was not at all sure that if ever the matter was threshed out, and a scheme formulated, there would not be some part of it relating to compulsion. The propositions already put before the public were very wide and numerous; there were contributory and non-contributory schemes, schemes for universal pensions for all persons of a certain age or limited to special classes of persons, or persons who showed certain kinds of conduct in the past; and there had been Royal Commissions and Parliamentary Committees on the subject. With regard to the universal schemes, he thought it was now almost admitted that, though they might be called universal, they would not be so in practice. When Mr. Charles Booth, who had promulgated a universal scheme, which was the most popular, suggested that it should be restricted by making those who were to receive pensions stand in a long queue, waiting perhaps for hours to be paid, thereby excluding persons of a higher rank who would not undergo such indignity or trouble, it could be seen to what extent the supporters of such a scheme had been driven to bring it within any kind of practicability. There was, he thought, an almost universal feeling that there must be some form of restriction, and, of course, that brought the universal scheme very near to the scheme which was a restricted one; and it was quite possible that if ever the conclusion was reached that a scheme was absolutely necessary, and that one must be devised, it might be a fusion of those two schemes. Mr. Chaplin's scheme for the deserving poor created very great difficulty. How were the deserving poor to be discriminated; how were they to be settled? Was it to be done by a public authority elected by the ratepayers, or was it to be done by a great army of State officials? He ventured to say in whatever way it was done there would be dissatisfaction on the part of the classes which more especially benefited by the pension. All that went to show how many difficulties had to be met before a satisfactory solution of the question was arrived at. There was the question also of the amount of the pension. Experience in Australia and New Zealand went to show that the smaller pension which was accepted at first by the working people was not likely to be accepted by them in perpetuity, and the amount which was paid originally by New Zealand has now, he thought, been doubled. After all, the matter was a question of cost. Although many might feel that it would be a great danger to the independence of people if pensions were given to all alike, whether thrifty or non-thrifty, yet it was the question of cost which would eventually cause the matter to be settled. Parliament was not likely to accept any scheme of which they did not see pretty clearly what the cost was likely to be in the future. He would like to give a few figures in connection with Denmark, showing how very much, within a comparatively short time, both the number of pensioners and the cost of the pension had increased. Denmark was in some respects like England—they had a Poor-law of their own, and the payments under that Poor-law, which were at the first moment somewhat decreased, had begun to rise again and now stood at a higher figure than at the commencement of the system of old-age pensions. In Denmark the number of pensioners in 1893 was 43,826; in 1905 they had risen to 66,878, while the cost had risen from 2,557,000 kroners in 1893 to 7,193,494 kroners in 1905. The fact was that experience had shown that people would arrange their circumstances so as to become eligible for an old-age pension, and, therefore, it was absolutely necessary to count from the beginning on an increase of cost on the original amount. It was not possible to deal with the question in a scientific society as a matter of politics, nor was it possible to deal with it as a matter of sentiment. Neither had they had to consider whether the principles upon which society was organised ought to be changed, but what under the present condition of affairs it was possible to do with the demand for old-age pensions.

Mr. H. W. Wolff thought that if a State-aided scheme of old-age pensions was to be established, the author's was the best. Sir Edward, however, was wrong in stating that no experience of such a scheme had yet been obtained in France, because the first year's results of the law passed in 1905 had just been published, which showed that 341,000 people had been assisted at an expense of 70,000,000 francs. That scheme was not in the form of a State pension, the burden of the payment being thrown upon the parishes, which found it a very heavy one. So far the pension had been 15 francs a month, which he did not think the people in this country would be satisfied with. There was now a measure before the Chambers which proposed to place the burden upon the State instead of upon the parishes. He entirely agreed with the author's statement that once a scheme was begun it could not be stopped, and that was exactly what had occurred in Germany. He had made a thorough study of the German old-age pension and working man insurance scheme, having interviewed the employees and the employers, and both found it a very great burden, and very irritating, as the author had stated It was openly admitted that if the question had been put to the people themselves, they would have declined to enter into such a scheme. For that reason it was absolute nonsense to say, as it was said some months ago at a Conference, that it was a co-operative scheme. Both in Germany and in Denmark the pension was very small, and he did not think the people of this country would be satisfied with such an amount. It had the further disadvantage that a great amount of money was withdrawn from productive purposes, and accumulated in the coffers of the State. Under that head alone, in 1902, 50 million sterling was accumulated in Germany, and the officers of the provincial departments had told him that they really did not know what to do with the money, until they discovered a

means for its employment, which he did not think the Chancellor of the Exchequer and Sir Edward would consider quite safe, namely, that it was used for the erection of working men's dwellings, the acquisition of small holdings, and similar purposes. He believed the principle was quite safe, although the people of this country would not hear of such a plan being adopted. He disagreed with the Chairman's hope that compulsion would be introduced, because from his experience of Germany and Denmark it led to a considerable amount of trickery and fraud. In a paper written by the director of the Poor Relief and Hospital Administration, for part of Copenhagen, on the subject of Danish old-age pensions, that statement was borne out, and it was further said that the law had to some extend defeated its own object by becoming less beneficial to the class of people it was intended to benefit. Exactly the same thing had happened in Germany. The Chairman had stated that compulsion would make the scheme universal, but the contrary was the fact in Germany. Some years ago one man in four escaped the compulsory payments, but the margin had now been reduced by the creation of a large staff of inspecting officers. Nevertheless, a great number still escaped. He found from the returns for 1904 that about a million people were drawing old-age pensions of £6 a year, and that 13,700,000 people were insured. The total number who ought to be insured according to the return was 14,500,000, but the return for 1893-4 showed that then 15,500,000 were in that category, of whom only 11,000,000 were insured; so that he thought the figure would be nearer correct if it were 16 or 17 millions, out of whom 13,700,000 were insured, and 1,000,000 of whom were drawing a pension which could not by any means be called sufficient. Any scheme which might be adopted in this country would be different from either the German or the Danish, but in principle it would more or less correspond to them; but he believed that once the paths of self-help were departed from, and people relied upon benefactions from the State, the same abuses would have to be dealt with and very similar results obtained.

Mr. T. Otley disagreed with the author's view that nobody should be entitled to participate in old age pensions unless he was able to pay something. He had a large experience of trades unions, and found that in years of trade depression a large number of members was lost simply because they were unable to keep up their contributions, and it would therefore be entirely wrong to deprive working men of pensions simply because they were unable to contribute towards them. Looking at it from the Socialist point of view, he contended there were millions of workers who found the wealth which enabled capitalists to live in a state of comfort, and he therefore considered it was only right that those who lived in a state of affluence through the labours of the workers should be made to contribute towards pensions for them when they reached 65 and were unable to keep themselves. A working man with four or five children was not able to spare anything in the way of a contribution to old-age pensions, especially when he was liable to be frequently out of work.

Mr. W. H. Beveridge disagreed with Mr. Wolff's statement of the condition of affairs which existed in Germany under the State pension scheme. While in Germany in the autumn he had several conversations with big employers of labour, and found there was no such disgust or desire to get rid of the expensive system to which Mr. Wolff had called attention. In his opinion it was necessary to keep the German and Danish systems distinct, because the latter was discriminatory, which encouraged lying, while the German system was compulsory. He thought the compulsory system worked in a straightforward manner, because it did not worry either the workman or the employer; and he could not imagine that such a system, if established in this country, would be in any way impossible or break down. The reason which made him desire to see such a system was that somehow or other everybody would be provided with an old-age pension. The paper provided for those who were willing to help themselves, but did not say anything about those who were thriftless and did not consider the future. It was not like provision for unemployment or sickness, because if such provision was made it encouraged people to be unemployed; but it was impossible to encourage people to become old, because they become old without encouragement. He thought everybody would agree that an attempt should be made to prevent old people from starving to death, and to do that they would cheerfully pay the extra expense involved. The only question was whether it should be done by general taxation or a compulsory contributory scheme. Personally he favoured the compulsory scheme, because he did not like people getting into the habit of looking to the State as a Lady Bountiful who would provide them with everything. He did not know, however, that it was necessary to introduce a compulsory contributory scheme at first. The scheme might be started by giving a grant to the people who made voluntary contributions in order to see how far encouragement would go, and then subsequently deal with the utterly thriftless and poor people by compulsion; just as in Germany if the workman did not insure voluntarily he was insured compulsorily. He did not think the people in this country ought to be frightened by any mere horror of German methods, because if social reform was wanted there must be regulation or the country would go to pieces.

Mr. Edward Slade stated that he was 73 years of age, and was exceedingly sorry to find that under the author's scheme he would be debarred from getting a State old-age pension, because he could not

pay the £1 and obtain the small annuity from it. He did not think that men who were not thrifty ought to be treated in the same manner as those who were; and differed entirely from the view that was often taken, that the State should provide for those who were not thrifty enough to look after themselves.

Mr. George King, F.I.A., thought that every scheme which was put forward with regard to old-age pensions raised difficulties that were almost insurmountable. Two schemes could be discussed; first, the contributory scheme, supported by Government subsidies; and, secondly, the universal scheme of giving to everyone without contribution. He thought the author's scheme, with certain variations, came under the first heading. While everybody longed for a satisfactory scheme of old-age pensions, he thought it was the duty of those concerned to find out how the difficulties could be overcome. The contributory scheme did not reach the poorest, because those who could not afford to make contributions were left out. The contributory scheme would provide a certain class of old-age pensions which were very useful in their way, but it would not get rid of the agitation which was always going on for universal old-age pensions. Under the author's scheme, there was a Government subsidy of the guaranteed rate of interest, but taxes would have to be imposed to raise the subsidy, and those taxes would be imposed on the poorest who could not contribute to the scheme. Then no limit had been fixed. He thought that generally there must be a limit to such a scheme, to the effect that a man earning more than so much a week would not benefit, but a difficulty was there created that those just above the line, who would not benefit, had the heaviest burden of taxation on them, and schemes which had a limit to them discouraged thrift above a certain point. Many schemes were placed before Lord Rothschild's committee, on which both the author and himself sat, but they all had to be discarded; and he was afraid that if Sir Edward s scheme had been brought before that committee it would have found its way into the same basket. He did not see how the contributory scheme could apply to the present generation. An elderly man was too old to begin to contribute, although he had work before him to do; and he was afraid Sir Edward had not sufficiently faced that difficulty. The first difficulty with regard to the universal scheme was its great cost. Another difficulty which he thought the trades unions and industrial classes had not yet faced was that at the age of 65, or whenever the pension began, there would be a subsidised class created, which would compete successfully with the rest of the industrial population in the labour market, which would tend to bring down the rate of wages. The industrial classes wonld not allow that to go on, and would say that those who were drawing old-age pensions, however hale and hearty they might be, must cease work. If able-bodied men and women (because women could not be left out of the question) were forced to be idle, an idle class who could not employ their time would be established, which would be bad both for them and for the community. Then there were the wastrels who would take their pensions on the Monday, spend them in the public house on Monday night and want relief on the Tuesday. In that respect he thought the universal scheme opened up very grave difficulties. If the author's scheme was largely adopted, another difficulty which would have to be faced was the thousands of millions sterling which would have to be invested, and that would entirely disorganise the money market. The fact also had to be borne in mind that the present generation were not touched by the author's scheme, and would have to be dealt with in another way; and he thought that was a far larger problem than Sir Edward seemed to suggest. He doubted very much, however, whether the scheme would be successful, because in old-age pensions distance did not lend enchantment to the view. His own view was that very few would take advantage of them, and that the problem would still be before them. Sir Edward had given the estimated cost of old-age pensions, based on figures worked out from tables and a guaranteed fixed rate of interest; but were the Government to guarantee a fixed rate of mortality? Actuaries knew that the rate of mortality in the country was falling, and, consequently, that the cost of old-age pensions starting at any age was increasing. If the pensions were fixed upon the rates existing at present, it was very likely that 20 or 30 years hence huge deficiencies would be found in the pension funds. He put that forward as a difficulty which had to be surmounted if such schemes were to be adopted. Shortly after Lord Rothschild's committee sat, he (the speaker) read a paper on the subject of old age pensions before the Insurance and Actuarial Society of Glasgow, and he there put forward what seemed to him then, and what seemed to him now, to be the only feasible scheme. He could not help thinking that the only feasible way was a development from the present Poor-law system, which should be changed so as to remove the stigma at present existing on those who were forced to use it. He thought that those who were past work, whether they were 50, 70, or 80, should have out-door relief if they were able to make proper use of it, but it should not be called out-door relief but old-age pension; and that those who could not make satisfactory use of such relief should not be sent into workhouses but into homes. He could not help thinking that by having a natural development from the Poor-law, not only the most satisfactory but the cheapest form of old-age pensions would be provided. It was quite true that at the present time all classes had a great horror of the workhouse, but he did not think it was past the skill of man to devise a plan for remedying that state of affairs, and thus solving the difficulty.

Mr. A. C. Rawlings was very sorry to gather from the author that it had been forced upon him that State old-age pensions were necessary. He (the speaker) had a large experience of Friendly Societies in Great Britain, amongst which for years past the impression had been slowly but surely growing that voluntary thrift organisations would solve the question so far as the thrifty classes of the country were concerned. The suggestion had been made that the poorer classes were unable to contribute, but it was a startling fact that it was found in the friendly society world that the strongest branches were in agricultural districts, amongst the poorest class of men whom one could least expect to save. Friendly society men naturally thought it would be a very bad thing for the thrify classes if State age pensions in any form were adopted. Referring to Mr. King's remarks with regard to out-door relief his own experience of late years was that since relief had been made more easily obtainable and the workhouses had been made more comfortable the working classes were not looking at them with the same horror that they used to in old days. Unfortunately it had the tendency to make sons and daughters say to their parents "It's not so bad, dad; you might just as well go into the home," and thus avoid the natural responsibility which rested upon them. If the scope of Poor-law relief was enlarged, it would act very adversely so far as true thrift and the responsibility of relatives was concerned. It appeared to him that the great difficulty in connection with the author's scheme, was that it was well-known from experience that voluntary deferred annuities in any form had not been successful up to the present. Young men and young women could not be led to think that they would live to a time when they would require old-age pensions, and that was the weakest link in the author's chain. He also disagreed with Sir Edward's statement that friendly societies could not earn 4 per cent. interest, as many friendly societies were earning that figure, and sometimes more. A well-known society, consisting of nearly a million members, had commenced a scheme of old-age pensions, a resolution having been passed propounding a scheme by which every member joining would secure to himself, as one of the benefits which he had paid, an old-age pension commencing at 65. He would receive sick pay up to 65 in addition to the usual insurance benefits; and at 65 the claims of sick pay would cease, and in the place thereof an old-age pension of 5s. a week be substituted. The actuaries had informed them that $\frac{3}{4}$d. a week, commencing at age 18, in addition to the present contribution would be sufficient to provide that pension. Some districts of the society had already commenced the work voluntarily—for instance, in Sheffield and Colchester, with great success. Friendly society people felt that if a privileged pauper class was constituted by the State it would be unfair to the thrifty classes generally of the country. They thought that those who tried to provide for themselves ought not to be taxed in addition for persons who did not attempt to provide for themselves, and who were to have an old-age pension on arriving at a certain age. He had been particularly struck with the statement made with regard to Denmark and Germany that there were a large number of persons awaiting the pension age who required help; they obtained charity in some form or other and had to be helped to subsist until the pension age arrived. That opened a very wide door for consideration as to what was to done for the men and women who were practically destitute and had not reached the pension age. With regard to trade unions he thought their sickness benefits and old-age pension funds were a fraud, because they were not kept separate; they were tied up with the war chests for fighting their battles.

Mr. Otley, interposing, said that the statement was incorrect.

Mr. A. C. Rawlings thought that his statement was right. He was quite willing to admit that trade unions had done a splendid work in the past with reference to thrift principles generally in getting the Workmen's Compensation Act passed, and so on, but it had made it difficult for men over 40 to get work, so that a serious condition of affairs would exist during the period between 45 and 65. There were many who believed that from the present time onwards the friendly societies and thrifty classes of the country would themselves solve the question of old-age pensions, although they knew they could not deal successfully with the unfortunate men and women who were unable to take advantage of voluntary effort.

Mr. George Dryden said that statistics proved that not more than 5 per cent. of members of friendly societies were over 65 years of age; and he thought that if every member at present paid 3d. a week it would be ample to pay 5s. a week old-age pension for all members as soon as they attained that age. In his opinion the present rate of taxation was so high that it was almost impossible to impose fresh taxation to produce the necessary funds to pay State pensions to all people who arrived at 65 years of age.

The Chairman, in proposing a vote of thanks to the author for his interesting paper, thought the trend of the discussion had been that the difficulties in the way were enormous, and no solution of them had been pointed out. Mr. King mentioned a number of methods, and in the end condemned them all; but it was a hopeful sign to find that members of friendly societies had stated their unabated confidence that they could deal with the question if they were only allowed to do so. He thought that was the keynote which ought to be struck in England at the present time, because it would be a most disastrous thing if, in default of finding a good method, some political

party, for the purpose of obtaining votes at an election, devised a scheme and carried it through Parliament without knowing where it would go. The most healthy elements of the population should be strengthened, and also those who had made the English friendly societies the admiration of the world in dealing with the less satisfactory element; and then they might look forward to the probability that England in a century's time would not be more demoralised than it was at present.

The ote of thanks having been carried unanimously,

Sir EDWARD BRABROOK, in reply, said he hoped Mr. King did not think he had retreated from the position they both occupied when they were members of Lord Rothschild's committee. He quite admitted that his scheme would have been condemned by that committee, just as all the others were, but it was proposed as being the one least open to objection of all the schemes of which he was acquainted, and not as a thing desirable in itself. He had been proceeding entirely on the assumption that old-age pensions of some sort would have to be brought forward, and he proposed his scheme as the least open to objection. With regard to the principal objections that had been made to it, everything must have a beginning. If his scheme were commenced immediately, some time must elapse before a considerable number of persons were entitled to pensions under it. There must be many ways in which those who were not entitled to benefit under the scheme might obtain relief in some other way. He was inclined to think that the hint thrown out by Mr. King as to some kind of modification of the Poor-law might be a very advantageous way of dealing with existing claims; but, of course, the mainstay of the hopes and expectations of the working classes of the country must be in their own thrift and exertions. Whether the scheme was adopted of handing over the money to the Government for investment, or the preferable scheme of investing it themselves, the thrifty class must look to themselves for their own salvation. He was disappointed to hear those who spoke on behalf of trades unions referring to the working classes as being helpless in that respect, and subject to disabilities. That was not the tone which, in his opinion, they should adopt. They ought to say that working men were able, by their own exertions, to provide for themselves, and if for any reason they were unable for a time to do so, there was something which needed remedying. Working men ought to be able to realise wages which were sufficient to provide for themselves now and in the future, and if they could not, they ought to know the reason. He, therefore, did not follow the argument that his scheme would leave persons without any help who were not able to provide large sums. He suggested that any sum that any person had to invest, might be invested in that manner; he did not ask for a regular contribution, but would give every man the opportunity of investing just as much or as little as he chose. On the whole, he had been very much gratified with the discussion, because it showed how very large a body of intelligent opinion was still averse to any general scheme of old-age pensions, and that a very much sounder view was taken by the audience than that adopted in organs of public opinion which had advocated wholesale pension schemes.

JAPAN: ITS FISHERIES AND AGRICULTURE.

FISHERIES.

Two monographs by Sir F. A. Nicholson on the fisheries and agriculture of Japan, have just appeared from the Madras Government Press, being the fruit of his recent deputation to Japan to report on these industries. Both play very important parts in Japanese economics, for the nutriment of the people is practically confined to vegetable food and fish, meat and dairy products being in general unknown, hence the necessary complement of agriculture is the fish supply. From time immemorial fishing has been universally practised on the 13,000 miles of coast which fringe the 116 islands of the kingdom. The fisher folk number about 5,000,000, or slightly over 10 per cent. of the aggregate population, while the gross value of the fisheries for the whole of Japan, except Formosa, and including fish, shellfish, seaweed, manure, and the additional value obtained by manufacture, averages annually £8,750,000. Statistics apart, it is clear the industry is of vast importance, and amounts to an annual catch of at least 30 lbs. a head. On the whole, Dr. Hugh Smith, of the United States Fisheries Department, remarks:—The fisheries of Japan are less valuable than those of several other countries, but they take first rank over those of all nations by reason of various special facts, viz., the number of persons directly and indirectly making a livelihood from the industry, the quantity of products annually taken from the water, the ingenuity and skilful character of the fishlng appliances, and the extent to which agriculture and utilisation of products have been carried. Particular danger and difficulty attach to Japanese fishing owing to the typhoons of summer and storms of winter. On an average 1,300 boats are lost per annum, while the climate is severe, especially in the north, where the herring, cod, and other fisheries are carried on, and where (*e.g.* in the fishing centre of Hokkaido) bitter weather with abundance of ice and snow prevail for many months. The fishermen are a hardy, venturesome race, who habitually go out many miles to sea in frail pinewood boats, mostly of no structural strength, small, wholly undecked, and without shelter save that of mats for the crew, and of very defective sailing powers. The Japanese navy is largely manned from men of this class, and with their hardihood is coupled an admirable facility for grasping new methods

in their own industry and elsewhere. As a rule the fisher folk are very poor, and usually indebted for working funds to capitalists; but they have groups of neat cottages instead of filthy hamlets too often seen elsewhere, and under the law which makes education universal, they are educated like others of the community, and able to profit by the teachings of the fishery schools, associations, and experimental stations.

Up to the time of the Restoration, the fisheries remained in their primitive condition, but after that there came an immediate change, and foreign methods were arranged to be studied with great care and system. One result was the establishment of a thoroughly equipped bureau within the Department of Agriculture and Commerce to deal with marine products. A Fishing Society, a private association of wide and practical scope, was also founded in 1881, and has attained a large membership and great usefulness. Conferences, local research, and experimental stations followed, these last resulting in improved boats, nets and lines, preservation and transport of fresh fish, pickling and smoking, canning and bottling, drying fish, and the culture of numerous breeds and genera. An Imperial Fishery Institute has also been founded, and was taken over by Government in 1897, and this has been instrumental in providing a body of well-trained experts. Among various products won from the Japanese seas may be mentioned iodine, coral (which previously to 1867 was obtained from Italy), and pearl-shell, used in inlaying lacquer and in many other forms of ornamentation and industry, and exported in vast quantities to China and European countries. Among these the pearl oyster and sea-ear (*Haliotis gigantea*) is well known and is not only exported but also worked up in the form of a large pearl-button and stud industry, from the small shirt button to the large, irridescent button an inch in diameter; the total weight of shells in 1904 was 4,000,000 lbs. Pisciculture applies particularly to salmon, which are plentiful in Hokkaido (the northern island), the edible oyster, pearl oyster, the snapping turtle, carp, eels, and gray mullet. Various interesting information regarding these different species is supplied by Sir F. Nicholson, but detailed notice is scarcely possible here. There is no doubt, however, that the data derivable from the experience and attention of the Japanese is worthy of attention in other parts besides India, for whose purposes the present monograph was primarily undertaken.

Agriculture.

Sir F. A. Nicholson's monograph on agriculture in Japan is naturally more complicated and far-reaching than that on fisheries, mainly owing, of course, to the number of important auxiliary subjects into which so wide a topic ramifies. A brief notice, therefore, must here suffice. At the outset, the author observes that in Japan one sees a country under *petite culture*, which for many centuries deliberately isolated herself from the outer world, and obtained all its supplies from its own resources. The arable area is extremely small and its population relatively large, yet it has fed this population satisfactorily, has reared a sturdy race, has paid very high rentals to a non-labouring or leisured class, has kept its soils not only unexhausted but fertile, and has done all this without imported food or manure, almost without cattle, and wholly without any mineral or artificial fertilisers. The explanation of this is to be found in the manuring and tillage system necessarily adopted, the utilisation of all waste (in matter, space, and time) as well as persistent, dogged, strenuous labour. The Japanese climate is peculiarly suited to agriculture, except in the colder parts of the north, the seasons being favourable and very regular, while the considerable rainfall, general moisture, and abundant sunshine enable rice, the mainstay of Japanese food, to thrive luxuriantly, as well as tobacco, maize, sweet potatoes and cotton. The gross area of Japan proper, omitting Formosa, is 94 million acres, of which the greatest part is mountainous and hilly. About $13\frac{1}{2}$ per cent. of the aggregate was arable land under cultivation in 1905; the remainder is mostly uncultivable. In the south almost every foot of the valleys has been already levelled and cultivated, while the hill sides are terraced in little fields, often to their tops. The crops on this small area, plus fish from the sea and some poultry and eggs, practically feed the whole Japanese nation, for meat, milk, butter, and cheese are not articles of their diet, while the imports of foodstuffs in one year would not feed the country for two weeks. The population thus subsist on an area of 0·267 acres per head, an area which for a self-contained nation appears to be of unparalleled minuteness. Yet the Japanese are the reverse of starved, they are particularly strong, sturdy, and well-nourished; begging is hardly existent, and emaciation not visible. The value of crops in 1902, viz., cereals and all other food crops, silk, tea, and straw to the extent of 16,424,584 crop acres, is given as 960,000,000 of yens, or about £96,000,000 sterling; in this are included silk, tea, and straw, the remaining ordinary crops being valued at £76,000,000 sterling. A good many of Sir F. A. Nicholson's notes are devoted to a full dissertation on the system of manuring in Japan, which is very careful and exhaustive: details of this are not requisite here, but there is no doubt that it is one of the most powerful agents in the great success of Japanese agriculture. The forests of the country form another remarkable and important feature. These cover more than 59 per cent. of the whole area of the empire, and special rules have been made from time immemorial for the preservatiou of woods and forests, the protection of the headwaters of rivers, the hindering of landslips and avalanches, the production of timber and firewood, and the conservation of valuable trees. The total forest area is divided into State, Crown, and private forests, consisting of 30·4, 3·5, and 18·5 million acres respectively. From the last-named the cultivators draw large stores of herbage and vegetable matter as green manure for their

fields, wood for implements and fuel, and timber and firewood for sale.

As in the case of fisheries, the Japanese Government have directly fostered agriculture by the establishment of a comprehensive and expert agricultural department under a Minister for Agriculture and Commerce, by experimental stations, agricultural schools, lectures and teachings by a chain of agricultural associations and diverse other stimuli. These various institutions are reviewed in detail, and their results during the past twenty years are pronounced as both marked and fruitful.

TURKISH EMERY STONE.

The district of Smyrna, together with the island of Naxos, practically monopolise the world's supply of emery stone. According to the American Consul at Smyrna the mineral is found in masses, principally embedded in limestone, and there appears to be no properly defined rule respecting its occurrence. All the emery mines in Asia Minor actually at work are situated two hundred miles south-east of the city of Smyrna. The quality of this emery as a rule varies with the mountain range in which it is found. Experience has taught thus far, that the mines situated near Smyrna have produced the best emery for polishing purposes, while those farther away have given the proper quality for "wheel" manufacturing. The difference which exists between these two grades of emery is simple, namely, the quality which is necessary for polishing purposes will not stand a high degree of heat nearly so well as that quality which is suitable for wheel manufacturing. It is also claimed that the emery necessary for polishing purposes must be of round grain, while that for wheel manufacturing must be flat, thus enabling the latter, when combined with the proper glue, to become a substance of extreme strength and hardness. Owing to the heavy demands made upon them the mines nearest Smyrna have now practically become exhausted; the only ones worked are at Cosbounar and Azizieh, on the Aidin railway, fifty miles south of Smyrna. After sixty years of work all the visible emery has been removed and the actual cost of extraction has doubled, for the reason that the ore now obtainable from these mines must be brought to the surface from long and deep underground galleries. The mine owners are now looking to more remote districts for their supplies. Owing to the comparatively low market value, and the excessive taxation on the part of the Government, this being 21 per cent. of the gross value, the mineral can only be worked superficially in districts not too far distant from sea or railway. The transport to the coast or railway station is daily meeting with greater difficulties. Every stone is brought from the mine on camels and donkeys. The emery mines most remote from Smyrna are those situated near the ruins of the ancient cities of Hierapolis and Aphrodisia, all of which produce flat-grain emery most suitable for the wheel trade. One thing which greatly militates against a healthy development of the emery trade is the question of transportation. It is impossible to secure regular transportation facilities for the mineral, for the reason that most of the mines are situated in distant mountain districts, and the camel drivers prefer to carry other goods, such as barley, oats, &c., even at a lower price, especially during years when the harvests have been plentiful. Donkeys and mules are not much resorted to, owing to their greater cost, and the endurance of these beasts of burden is less than that of camels. The emery mines in Asia Minor are worked in the most primitive fashion. Skilled labour is not employed. The ore is quarried out of the mines without explosives. Labour in the districts of Kuluk, Moulah, and Kuyudjak, from whence come the largest quantities of emery, cost barely from 5s. 2d. to 7s. 6d. per ton, while in the mines of Cosbounar, Azizieh, and Sarakeny it costs not less than from 25s. to 30s. per ton to mine it. The total shipments from Turkey per annum amount to 20,000 tons, and 7,000 tons from the island of Naxos. Sixty per cent. of the foregoing is shipped to the United States and 40 per cent. to European markets. During the year ended June 30, 1907, the value of the exports to the United States amounted to £41,000.

GERMANY'S FOREST REVENUE.

According to statistics recently prepared, the total quantity of timber cut in Saxony during the year 1906 is estimated at 1,231,472 cubic yards, 210,947 cubic yards representing wood used for fuel only, and 1,020,525 cubic yards representing wood sold for all other purposes. To this must be added a yield in brushwood, cut and sold for fuel uses principally, of 190,415 cubic yards, raising the total quantity of timber and brushwood cut and sold in 1906 to 1,421,887 cubic yards, for which the sum of £675,000 was obtained. This amount was further increased by additional revenue from the leasing of meadows, hunting privileges, and other rights to the total of £700,000. The American Consul at Eibenstock, commenting on these figures, says that deducting from the total amount the cost of forest cultivation (with salaries and wages of the entire service included) amounting to £272,000, the net profit of £428,000 was added to the State Treasury in 1906. There is nothing unusual in this result, as the ten preceding years show equally high figures, a few slightly exceeding the revenue of 1906, others being lower to a very small degree. The same comparison applies to the area cultivated, and timber obtained in the ten years. Similar results have, it is said, been achieved in other German States by systemetic forest cultivation. About 50,000 square miles of German soil have been adapted to foresting, the value of the wood gained therefrom being estimated at £12,000,000 a

year. In all the German States, revenue for the State Treasury is the paramount consideration in determining the species of trees to be planted on Government land. Formerly the deciduous - tree varieties were planted in preference to the needle-leafed kind. The principle demand for the former was for fuel purposes. However, since coal has replaced the deciduous tree in this respect, the price of such wood has fallen accordingly. On the other hand, that of the needle-leafed variety steadily rose until to-day it has become more profitable to plant the latter. This rise is largely due to growing industrial demands for this variety of wood for raw material. The gradual increased cultivation of pine forests in the mountainous region of Saxony has been followed by a remarkable development of industries using the wood of the red pitch pine, the most rapidly growing, and best adapted mountain pine, selected by the Saxon Government because more profitable than other species that can be cultivated in Germany. It has been established that 80 per cent. of the trunk of this pine is available for industrial purposes alone, in addition to its use for fuel, exceeding in this respect every other needle-leaf tree, and by far the deciduous species, of which the beech, for instance, only shows 20 per cent. of usefulness of its trunk for industrial purposes. The beech, formerly abundant in Saxon forests, has therefore not been replanted to any extent, and the much more remunerative red pitch pine now predominates all over Saxony. In manifold uses this tree is superior to any other. It is used in mine construction, for building purposes, floors, barrels, boxes, resounding boards for pianos, furniture, cooperage material, poles, vine props, lathes of all kinds, &c. With the ascendancy of wood-pulp and cellulose manufacturing, the usefulness of this tree was increased still more. An example of how industries follow the preservation and cultivation of forests is furnished by the fact that already in 1890 as many as 534 wood-pulp factories existed in Germany; of these 239 were situated in Saxony where they consumed 575,260 cubic yards of pine-wood, representing a value of £240,000. The beginning of this industry only dates back to 1843, when a Saxon invented the process. Since 10 per cent. of the trunk of this tree is composed of bark available for tanning, it is also used for such purposes. It is easily scaled in summer, and new trees which have been felled in February and March can be thus utilised so long as the sap circulates, if the trees are stripped of their branches immediately when cut down. This scaling is considered an advantage to the rapid drying of the logs, and also in a measure a protection against the ravages of a bark beetle. Formerly the resin from this tree obtained a good price. The red pitch pines' value to forestry is greatly enhanced because it flourishes where deciduous forests are greatly hampered, namely in mountainous regions with altitudes varying from 1,500 to 4,500 feet. The Saechsische Erzgebirge, a range of mountains separating Saxony from Bohemia, and of which Eibenstock may be considered the central city, has been transformed from a non-productive region, except for small yields of rye, oats and potatoes, to one covered with pine forests of the finest growth. Saw mills, wood-pulp, paper and manufacturing establishments in prosperous condition are situated throughout the district. About 4,000 manufacturing establishments employing close on 60,000 people have been set up in connection with the Saxon forests.

ADMIRALTY CHARTS.

The following is the official list of charts issued by the Hydrographic Department of the Admiralty, in October, 1907:—

New Charts.—No. 3607—Scotland, west coast:—Sound of Mull, eastern portion. 3669—Scotland, west coast:—Uig bay. 156—Sweden:—Väderöbod to Maseskär. 129—Sweden:—Maseskär to Vinga. 3667—Sweden:—Nidingen to Tylö. 3671—Sweden:—Tylö to Viken; Halmstan harbour. 2580—United States, east coast:—East river and northern approaches to New York. 3658—Formosa, north coast:—Auran road to So O wan; So O wan (Suao bay). 128—Japan, inland sea:—Channel between Bingo nada and Ozuchi jima.

New Plans and Plans added.—No. 4—Principal groups of the Chagos archipelago. New Plan:—Salomon islands. Plan added:—Entrance to lagoon. 991—Japan:—Anchorages on the coasts of Yezo island. New plan:—Mombetsu anchorage.

Charts that have received additions or corrections too large to be conveniently inserted by hand, and in most cases other than those referred to in the Admiralty Notices to Mariners:—

No. 2472—Scotland, west coast:—Loch Gilp. East, loch Tarbert; Millport. 2639—Scotland, west coast:—Loch Carron and lock Kishorn. 109—England, east coast:—Entrance to the river Humber; Grimsby road. 196—Swden:—Nidingen to Hönö. 2158*a*—Mediterranean sea, western sheeet. 2158*b*—Mediterranean sea, eastern sheet. 2516—Gulf of St. Lawrence and the river to Quebec. 472—Harbours and anchorages on the coast of Haïti or San Domingo. 2820—Gulf of Mexico:—Entrance to Pensacola bay. 627—Africa, west coast:—St. Paul de Loanda to Great Fish bay. 748*a*—Indian ocean, southern portion. 748*b*—Indian ocean, northern portion. 40—India, west coast:—Karachi harbour. 833—Bay of Bengal:—Rangoon river and approaches. 776—China sea:—Shieng Mun to Tra ko island. 854—China, east coast:—Port Swatau. 2400—China, east coast:—The bar and approaches to the river Min. 3585—China, north-east coast:—Approaches to the Wusung river. 3025—China, north coast:—Wei hai wei anchorage. 452—Japan:—Yezo island with adjacent straits 214—Solomon islands.

These charts are published by Mr. J. D. Potter, 145, Minories.

HOME INDUSTRIES.

Trade Marks in Japan.—Complaints of Japanese trade-mark piracies have become very numerous, more especially in trades concerned in the imports of various small articles of a miscellaneous character. It is even said that the copying of labels and trade-marks has become almost a leading Japanese industry. The attention of the Japanese Government having been directed to the matter, the Patent Bureau have now requested the Yokohama Foreign Board of Trade—composed of foreign merchants—to make known its desire to secure to everyone the protection accorded by law. The Bureau will be glad to receive particulars for its records of all trade-marks which are still in use and were in existence and use prior to July, 1899. It would seem that many of the difficulties which have arisen are due to the neglect of foreign merchants and manufacturers in not registering their marks in Japan. The Bureau is thus unable to detect infringements, and rights are registered which afterwards become the subject of dispute. Marks cannot be registered in Japan if they are identical or similar to marks used by another before July, 1899, provided such trade-marks have since continued in use. Under the law of Japan the terms of patents and the exclusive use of designs and trade-marks are fifteen, ten, and twenty years respectively, counting from the dates on which they are registered in the official records. The owners of letters patent or registered designs pay progressive fees annually, and the owners of trade-marks pay the fixed fees when making the application for registration. In the following cases the director of the Patent Bureau is entitled to revoke the patent: (1) when a patentee fails to pay the fee; (2) when a patentee rejects a reasonable offer of a third person to purchase or tax his right in case of not exploiting his invention in the empire within three years from the date of issue of the license, or in case of snspension of such exploitation for three years; (3) when a patentee not residing in the empire fails to appoint a proper agent. Similar regulations are provided for with respect to designs and trade-marks.

The Railway Companies and Coal Owners.—What may be called the rate quarrel between the railway companies and colliery owners is developing. Recently attention was directed in these Notes to the action of the railway companies in depriving the collieries of the advantage they had hitherto enjoyed by reason of the weighing allowance. Now it is announced that the Great Northern, the Great Central, and the Midland companies are increasing, as from December, the rates on coal conveyed from some fifty collieries in Nottingham and Derbyshire to Leicester and Syston by additions varying from 1d. to 3d. per ton. This revision of rates seems to be gradually embracing the whole of the country, and it is not surprising that the alterations are keenly resented by the coal trade. It is not unlikely that the Government will be pressed to have the whole matter of railway charges for coal gone into by the Board of Trade.

Spirits for Industrial Purposes.—The number of British makers of British plain spirits intended for methylation is rare, and of late the competition between them has been so keen that the margin of profit almost disappeared. These concerns have now decided to combine. The combination is formed somewhat on the lines of the German cartel. The whole output of all the making will be sold through one central agency at one uniform price. The selling agency, which was registered in October, will be known as the Industrial Spirit Supply Company, Limited. The combination will differ from the German cartel in that there will be no pooling of profits, each company making and retaining its profit on the production of the spirit as heretofore. But since all the orders received through the central agency will be allocated to the various producing concerns in proportion to their share holdings in the company competition will be practically eliminated. Orders will be sent to the company who will, as far as possible, hand them on to the distillers nearest the destination of the spirit ordered. A difficulty which presented itself was that of equalising the slight advantage possessed by those distillers who also methylated the spirits they made. This has been got over by these distillers paying into the company a share per gallon equal to the commission payable by the combined distillers to the agents who have the handling of the output. It is claimed by the distillers that the arrangement come to is only one for the regulation of the output and the elimination of cut-throat competition. And it is expected that with the knowledge that they are all buying on the same terms, the methylators will be better able to obtain something like uniformity in their selling prices. Somewhat similar agreements have been entered into in the past but they have not been rigidly adhered to. It remains to be seen whether the present agreement will be more lasting. It is understood that it is simply an honourable understanding, each party pledging himself to observe it until further notice.

The Wheat Yield.—The agricultural returns for the year give a much larger yield than was at one time anticipated, being no less than 33·97 bushels. Last year it was only 33·66, and in 1905 only 32·78. The largest yield per acre ever recorded was in 1898, when it reached 34·75. How greatly acreage and yield have fallen during the last forty years, and as a consequence our dependence upon the foreigner increased, will be seen from the following figures:—

	1868.	1907.
Acreage	3,937,000 ..	1,665,000
Crop (lbs.) ..	16,875,000 ..	7,062,000
Net Imports (lbs.)	7,720,000 ..	26,500,000

In France, on the contrary, so far as the present year is concerned, the land has yielded more wheat than

the people require, and the price of wheat is very little more than in the United Kingdom, where it looks as if rates must rise considerably above the present high level before the winter is over. Fortunately the Argentine crop is likely to be a record one, amounting to exports exceeding 15 million quarters. The American harvests have been very poor; there is scarcity in Russia and Roumania, and famine over a large portion of India; and the Australasian exports will be less than last year. All indications, therefore, point to growing scarcity and higher prices in the coming months.

Colonial Trade Legislation.—The Association of the Chambers of Commerce recently passed a resolution urging the Government to make arrangements to obtain for British Chambers of Commerce, and other representative commercial institutions, full information of the contents of all Bills and other proposals introduced into the legislatures of British colonies, the provisions of which are likely to affect the interests of British manufacturers, shipowners, or traders. The need for further and fuller information has long been felt; and, in reply to the resolution, the Colonial Office has intimated that steps have now been taken to secure the earlier transmission to this country of Colonial Bills affecting commercial interests, and these will be published in the *Board of Trade Journal* as soon as they are received.

The Manchester Docks.—A large party of Manchester cotton spinners visited the Manchester Docks last week, and are stated to have been much impressed with the great extent and admirable character of the accommodation now afforded by the port of Manchester for direct cotton imports. The cotton is handled by the ship company's men in a very careful and expeditious manner. Bnt perhaps, says the *Manchester Guardian*, in commenting upon the visit, the most striking sight was the contrast afforded between the condition in which American and Egyptian commodities arrive in this country. "Beside the same quay the steamers *Eastry*, from Savannah, and *Merchant Prince*, from Alexandria, were both discharging cotton cargoes. Out of the hold of the *Eastry* came a constant succession of what can only by courtesy be described as bales at all; they looked more like dilapidated rag bags; in spite of the most careful handling, they shed part of their precious contents at every movement, and it was perfectly obvious that never at any time had the majority of them been even decently covered. Out of the *Merchant Prince* came the Egyptian bales, perfectly rectangular, neat, and trim, clearly marked, and with hardly a lock of cotton visible anywhere. The American bales may have suffered severe treatment on the other side before shipment—doubtless they had—but that is a reason why they should be better, not worse packed. The truth is that the wrappers on American bales have almost ceased to be a scandal, and have become mere derision. They are no longer wrappers, but a technical pretence—vestiges still discernible, but becoming fainter and fainter, of an ancient custom long ago abandoned, of protecting American cotton from wet, dirt, and loss in transit." It is surprisiug that Engish and Continental spinners—who, after all, have the power to insist upon reform—continue to tolerate packing of this sort.

Small Holdings.—The Burwell small holdings scheme has now had a year's trial with results that must be considered very satisfactory. The rent audit has just been held and the agent was able to report that there are no arrears. And not only are the occupants of the holdings doing well and paying their way, their success has brought about quite a land hunger in the district, no fewer than thirty-six new men having applied to the Burwell Parish Council for holdings of from five to forty acres in extent. No doubt the present has been an exceptionally good year in which to try the experiment, but there is no reason to doubt that with due attention to their business the tenants can count upon continued success. The promising outlook at Burwell should quicken the desire for such holdings in other parts of the country and encourage the local authorities to follow the Burwell example.

Cotton Profits in 1906-7.—Figures given by Mr. William Tattersall in his cotton trade circular indicate the large profits made by the textile companies in 1906-7. Mr. Tattersall gives a list of 37 cotton spinning companies which have taken stock for the preceding six months whose profit figures work out at 40 per cent. per annum on the share capital, and 30 per cent on all capital employed The total of the share capital was £1,451,741, and the loan capital £514,129. The outlook for the present season is less assured. Although spinners continue to enjoy great prosperity, and even are said to be improving upon the earnings of 1906, the weavers complain that it is impossible to obtain orders at remunerative prices. During the past four years there has been a great increase in the number of looms, some 90,000 looms having been brought into operation since 1903. During the past seven years no fewer than 123 new mills containing 11,000,000 spindles, have been erected at a cost of £14,000,000, and the number of spindles in course of erection to be at work in 1908 is put at about 2,360,000. The exports of cotton yarn for the ten months ended October amounted to 199,571,100 lbs., valued at £12,728,798, as against 173,777,400 lbs., valued at £9,798,551 in 1906, much of the increase being due to the continental demand. The outlook for the spinning industries continues fair, but the increase in spindles, wages, and the cost of fuel must affect profits, and, apart from the uncertainties of the crop outlook, Lancashire cannot expect to escape entirely from the trade reaction which seems imminent all over the world.

GENERAL NOTES.

The Supply of Teak.—The Siam teak trade appears to be threatened by the increasing export of this timber from Java. Java teak, though said to compare unfavourably with Burma and Siam teak in the matter of lengths and texture, seems to be gaining a footing in the United Kingdom. In his report on the trade of Bangkok, just issued (Cd. 3727-21), Mr. Acting Consul Crosby quotes a local teak merchant for the statement that though the figures available regarding the export of Java teak in recent years are vague, the safe conclusion may be drawn from them that the export of Java teak is increasing by leaps and bounds, and that the surplus will admit of the export being multiplied three or four times, as the demand for the wood becomes more established. An equally important consideration from the point of view of the Siam teak exporter is the action which, it is rumoured, the Government of Burma contemplates taking to relax certain of the restrictions hitherto placed on lessees of their forests, and more particularly to extend the period of leases from 6 to 15 years. The increased facilities for extracting timber which will result from such action, if taken, may have the effect of placing forest lessees in Burma in a favourable position as compared with those in Siam, unless Siamese Forest Conservancy regulations are altered *pari passu* with those of Burma.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

December 11.—"Radio-active Phenomena." (Aldred Lecture.) By Sir William Ramsay, K.C.B., Ph.D., LL.D., Sc.D., F.R.S. Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Chairman of the Council, will preside.

December 18.—"Le Rôle de la France en Afrique Occidentale." By Monsieur Lucien Hubert, Député des Ardennes. The author will read his paper in French.

Indian Section.

Thursday afternoon at 4.30 o'clock:—

December 12.—"Big Game in India." By Reginald Gilbert, F.Z.S., late of Bombay. The Right Hon. Lord Harris, G.C.S.I., G.C.I.E., will preside.

Applied Art Section.

Tuesday evening, at 8 o'clock:—

December 17.—"How to Make the Most of a Museum." By Lewis Foreman Day, F.S.A. Sir Aston Webb, R.A., F.R.I.B.A., will preside.

Shaw Lectures on Industrial Hygiene.

Friday evenings, at 8 o'clock:—

December 13.—"Industrial Poisons—Lead and Phosphorus, with special reference to Lucifer Match Making." By Professor Thomas Oliver, M.D.

Papers for Meetings after Christmas (dates not fixed):—

"Screen-Plate Processes of Colour Photography." By C. E. Kenneth Mees, D.Sc., F.C.S.

"The Problem of Road Construction, with a View to Present and Future Requirements." By H. S. Hele-Shaw, LL.D., F.R.S., and Douglas Mackenzie.

"Recent Improvements in Decorators' Materials." By A. S. Jennings.

"The Underground Water Supplies of the Thames Basin." By Clayton Beadle.

"Industrial Entomology: the Economic Importance of a Study of Insect Life." By F. Martin Duncan.

"Modern Dairy Practice." By Loudon M. Douglas.

"War Balloons." By Auguste E. Gaudron.

"Siam and its People." By Harry Hillman.

"The Application of Science to Foundry Work." By Robert Buchanan (President, Staffordshire Iron and Steel Institute).

"The Law of Treasure Trove." By William Martin, M.A., LL.D.

"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By Ernest R. Matthews, F.R.S.E., Assoc.M.Inst. C.E.

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Conrad Beck, F.R.M.S., "The Theory of the Microscope." Four Lectures.

Lecture III.—December 9.—*Influence of Diffraction.*—Explanation of diffraction—Slit—Convergent cone—Diffraction pattern or antipoint—Its influence on telescopic images—Its size—Abbé theory—Gordon's attack on Abbé theory—Relation of aperture to magnifying power—Oil immersion—Shape of and methods of reduction of size of antipoint—Limits of resolution and visibility—Special cases—Diffraction of the eye.

Lecture IV.—December 16.—*Applications of Theory.*—Best combination of eye-piece and object-glass—High power illumination—Gordon's oscillating screen—Useless aperture—Penetration for visual and photographic work—Effect of cover-glass—Substage condensers—Achromatism and aplanatism in condensers—Angle of illuminating cone—Illuminants—Monochromatic light—Wright's experiments—Critical illumination—Possible advances.

The Lectures will be illustrated by Lantern slides and Experiments.

Juvenile Lectures.

Two Lectures suitable for a Juvenile audience will be delivered on Wednesday afternoons, January 1 and 8, 1908, at 5 o'clock, by F. Martin Duncan, on "The Scientific Applications of the Cinematograph."

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

January 16, February 13, March 12, April 30, May 21.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

January 28, February 25, March 24, April 7.

Applied Art Section.

Tuesdays, at 4.30 or 8 o'clock :—

January 21, February 18, March 31, April 28, May 26.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Henry Hardinge Cunynghame, C.B., "The Theory and Practice of Clock Making." Six Lectures.

January 20, 27, February 3, 10, 17, 24.

Professor Vivian B. Lewes, "Fuel and its Future." Four Lectures.

March 9, 16, 23, 30.

William Burton, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.

May 4, 11, 18.

Shaw Lectures on Industrial Hygiene.

Dates not fixed :—

"The Removal of Dust and Fumes in Factories." By John Scott Haldane, M.A., M.D., M.R.C.P. (Edin.), F.R.S.

"The Dangers of Coal Dust and their Prevention." By W. E. Garforth, President of the Colliery Proprietors' Association of Great Britain.

"The Hygiene of the Pottery Trade." By William Burton, F.C.S., Chairman of the Joint Committee of Pottery Manufacturers of Great Britain.

"Child Workers and Wage Earners." By Miss Nettie Adler, Hon. Secretary to the Committee on Wage Earning Children.

Howard Lectures.

Thursday evenings, at 8 o'clock :—

H. S. Hele-Shaw, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

March 19, 26, April 2.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 9...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Conrad Beck, "The Theory of the Microscope." (Lecture III.)

Farmers' Club, Whitehall-rooms, Whitehall-place, S.W., 6 p.m. Mr. Alfred Mansell, "The Value of Live Stock on the Farm."

Engineers, 17, Victoria-street, S.W., 6½ p.m. Annual General Meeting.

Surveyors, 12, Great George-street, S.W., 4 p.m. Mr. George C. Phillips, "The Calculation of Equivalent Manurial Values."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Dr. Vaughan Cornish, "The Jamaica Earthquake and After."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Rev. D. Gath Whitley, "Primeval Man in Belgium."

London Institute, Finsbury-circus, E.C., 5 p.m. Dr. W. Evans Darby, "The Political Machinery of Peace."

Tuesday, Dec. 10...Junior Institution of Engineers (at the House of the Society of Arts, John-street, Adelphi, W.C.), 8 p.m. Mr. W. Krause, "Arc Lighting."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Charles Ashley Carus-Wilson, "The Predetermination of Train Resistance."

Photographic, 66, Russell-square, W.C., 8 p.m. Messrs. W. F. Cooper and W. H. Nuttall, "Agar Agar in Emulsion-making and a Sepia Paper."

Zoological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Sir Alfred Sharpe, "Nyasaland."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Wednesday, Dec. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Aldred Lecture.) Sir William Ramsay, "Radio-active Phenomena."

Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

Japan Society, 20, Hanover-square, W., 8½ p.m. Mr. E. F. Strange, "Toyokuni I., and his Theatrical Colour Prints."

British Archæological Association, 32, Sackville-street, W., 8 p.m.

Thursday, Dec. 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Reginald Gilbert, "Big Game in India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Sir Alexander Mackenzie, "Bohemian School of Music."

Mathematical, 22, Albemarle-street, W., 5½ p.m.

Friday, Dec. 13 ... SOCIETY OF ARTS, John street, Adelphi, W.C., 8 p.m. (Shaw Lectures on Industrial Hygiene.) Professor Thomas Oliver, "Industrial Poisons—Lead and Phosphorus, with Special Reference to Lucifer Match Making."

Astronomical, Burlington-house, 5 p.m.

Physical, Royal College of Science, South Kensington, S.W., 7 p.m. Annual Exhibition of Apparatus.

Journal of the Society of Arts.

No. 2,873. VOL. LVI.

FRIDAY, DECEMBER 13, 1907.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 16, 8 p.m. (Cantor Lecture.) CONRAD BECK, "The Theory of the Microscope." (Lecture IV.)

TUESDAY, DECEMBER 17, 8 p.m. (Applied Art Section.) LEWIS FOREMAN DAY, "How to Make the Most of a Museum."

WEDNESDAY, DECEMBER 18, 8 p.m. (Ordinary Meeting.) Monsieur LUCIEN HUBERT, Député des Ardennes, "Le Rôle de la France en Afrique Occidentale." The author will read his paper in French.

Further details of the Society's meetings will be found at the end of this number.

H.M. THE KING OF SWEDEN.

By the lamented death of King Oscar of Sweden the Society loses one of its oldest Honorary Royal Members. King Oscar was elected in 1876 on the proposition of Lord Alfred Churchill, who was then Chairman of the Council.

CANTOR LECTURES.

Mr. CONRAD BECK, F.R.M.S., delivered the third lecture of his course on "The Theory of the Microscope," on Monday evening, 9th inst.

The lectures will be published in the *Journal* during the Christmas recess.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience, will be delivered on Wednesday afternoons, January 1st and 8th, at 5 o'clock, by F. MARTIN DUNCAN, on "The Scientific Applications of the Cinematograph."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

NORTH LONDON EXHIBITION TRUST.

In 1865 the Committee of the North London Working-classes and Industrial Exhibition (1864), presented to the Society of Arts a sum of £157, the balance of the surplus from that Exhibition, with a view to the award annually of prizes for the best specimens of skilled workmanship exhibited at the Art Workmanship Competitions of the Society of Arts. The Art Workmanship Competitions were discontinued after 1870, but since that date various prizes have been awarded under this Trust. Prizes were offered to the students of the Artistic Crafts Department of the Northampton Institute, Clerkenwell, in 1903, and have been continued annually to the present time. These have been awarded, for the present year, as follows:—

1st prize (one moiety), value £5 15s. 6d., to E. C. WIGGINS, for a Jewelled and Enamelled Pendant.

1st prize (one moiety), value £5 15s. 5d., to H. R. F. LEITH, for an Engraved Copper Plate after Albert Durer.

3rd prize, value £3 3s., to W. W. MEEDY, for Examples of Engraving for Copper Plates.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

Wednesday, December 11th, 1907; Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Vice-President and Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Astley, Reginald B., Acton Reynold, Shrewsbury.
Dos Santos, José Americo, M.Inst.C.E., Caixa 748, Rio de Janeiro, Brazil, South America
Hamilton-Gordon, Ernest Arthur, Fire Brigade Headquarters, Southwark, S.E.
Heaton, Noel, B.Sc., F.C.S., 20, Baker-road, Harlesden, N.W.
Jones, William Arthur, Electricity Works, Cathall-road, Leytonstone, N.E.
Richards, Richard Slome, Lakeside, Bourne End, Bucks.
Stamp, William Frederick, A.M.I E.E., 11, Brunswick-place, Stoke, Devonport.
Thorn, Cyril Hunter Robert, 42, Elm-park-gardens, S.W.
Whittick, Fred. G., Imperial Provincial College, Tsinanfu, Shantung, China.

The following candidates were balloted for and duly elected members of the Society:—

Coode, Arthur Treveneu, B.A., 45, Abingdon-villas, Kensington, W.
Foster, Vivian Le Neve, M.A., Eton College, Windsor.
Gaskell, Mrs. Ada E., Woolverton, St. Lawrence, Isle of Wright, and 98, Portland place, W.
Haviland, Henry A., M.B., Magila, Tanga, German East Africa.
Johnston, William Caley, P.O. Box 44, Bocas del Toro, Republic of Panama.
Simonis, Henry, LL.D., Norfolk-house, Norfolk-street, Strand, W.C.
Vale, William, Tower-house, South Norwood, S.E.

The Chairman (Sir Steuart Colvin Bayley) said it was usually the duty of the Chairman to introduce the lecturer to the audience, but on the present occasion he felt it would be an insult to the intelligence of those present to offer to introduce Sir Willliam Ramsay to them. One who had been honoured, not only in his own country, but by foreign sovereigns and by almost every scientific and philosophical institution on the Continent, needed no introduction to an audience which, from necessity, was mainly a scientific one. He desired, however, to say a few words with reference to the foundation of the lecture under the Aldred Trust. Dr. Aldred, who died some years ago, left a small sum of money with a view to a prize being given annually for an essay on some scientific or literary subject. The money, as it turned out, was not sufficient to produce an amount of interest which would provide the prize, and the Council of the time being decided to let the interest accrue until it did. Ultimately, looking upon the failure which generally arose from having competitive essays for a prize, they decided that it was better to ask a gentleman of scientific eminence to give a lecture on his own subject; and he was quite sure that if Dr. Aldred knew how his wishes were being carried out, he would be the first to delight in having a lecture given under his name by such a distinguished scientific man as Sir William Ramsay.

A RADIO-ACTIVE GAS.

(*Aldred Lecture.*)

By Sir William Ramsay, K.C.B., Nobel Laureate, F.R.S.

The word "radio-active" has become familiar to all who read the scientific literature of the day, and it has even grown to be a commonplace of newspapers. But as few readers, perhaps, have more than a general idea of its meaning, a word on the matter may not be out of place, seeing that we have to-night to consider "radio-activity" as a property of a gas.

It was Newton who first employed the old English word "ray" in a definite sense. He used it indeed, either in the sense of undulations, or in the sense of corpuscles. You may remember that Newton rejected the undulatory theory of light; he wrote:—"Since light is propagated in right lines, it is certain that it cannot consist in action alone." And again, "Because of the analogy there is between the propagation of the rays of light and the motion of bodies, I thought it not amiss to add the following propositions for optical uses; not at all considering the nature of the rays of light, or enquiring whether they are bodies or not; but only determining the trajectory of bodies which are extremely like the trajectories of the rays."

A ray, then, may consist either of shot-out particles; or it may be a bundle of ethereal vibrations; both are propagated in straight lines. To radiate is to send out rays; and a radio-active substance is one which is active in sending out rays.

We do not, however, speak of a candle as being radio-active; nor a tea-kettle. The word has come to mean capable of emitting

rays which will effect the discharge of an electroscope at a distance. It has, of course, long been known that a pair of strips of gold-leaf, suspended from an insulated support, would diverge if touched with a rubbed piece of glass or of sealing-wax; the former charges them "positively," the latter "negatively." Up till recently, however, the expressions "positive" and "negative" were merely names to signify certain states; they conveyed no definite meaning. But recently, thanks to the researches of Professor J. J. Thomson and his pupils, we know that a "negatively" charged body is one to which certain small particles termed "electrons" have been added; and contrary to the direct signification of the name, a "positively" charged body is one from which electrons have been removed.

It is also widely known that Henri Becquerel, in 1896, discovered that salts of the metal uranium continuously emitted radiations capable of impressing a photographic plate in the dark; and also of discharging an electroscope near which they are placed; there need be no actual contact. It was previously known that violet and ultra-violet light, shining on an insulated polished plate of zinc to which a negative charge of electricity had been imparted, discharged the plate; not so, if it were charged positively. It was known, too, that the proximity of a flame discharged an electroscope, whether it had been charged positively or negatively. But these examples of discharging were the result of chemical processes; the light was maintained by the burning of a candle, or by some similar contrivance, involving an expenditure of energy to keep it in action. The activity of uranium salts, however, stood on another basis; there appeared to be no change in the condition of the uraninm, and it seemed to furnish an inexhaustible supply of energy. Now it is an axiom of experience that it is impossible to create something out of nothing; a perpetual-motion machine has again and again been shown to be an impossibility; and yet uranium and its salts served as a source of apparently perpetual energy. Theoretically, observations on uranium and its discharging power looked as if a machine could be contrived which would run for ever under the influence of uranium in its neighbourhood, and the problem of obtaining perpetual motion appeared to be solved.

Madame Curie, some years later, after finding that the discharging power of pitchblende, the chief source of uranium or its salts, was greater than could be accounted for by the uranium it contained; and you all know that her long and laborious research resulted in the discovery of a constituent of pitchblende, nearly two million times more radio-active than oxide of uranium. To this substance she gave the name "radium." No one has ever seen the metal; no doubt it could be prepared, but its salts are too costly to risk the experiment. No doubt, also, it would be a white, hard, easily oxidisable metal, closely resembling calcium (of which I show you a specimen); for its salts closely resemble those of calcium; and still more closely, those of another closely allied metal, barium, and these have both been prepared in the metallic state.

It was soon discovered that there is no need for the salt of radium to be near the electroscope. Provided there is a tube connecting the vessel containing the electroscope with that containing the radium, the electroscope cannot be charged, or if an attempt is made to charge it its leaves always fall. But by closing a stop-cock on this tube, after a time there is no difficulty in charging the electroscope. Something is evolved from the radium which can pass along a tube. It was not long before it was recognised by Dorn that this substance must be a gas; for only a gas can transfer itself in such a manner from one vessel to another along a connecting tube.

Somewhat similar properties were found to belong to salts of the much commoner metal thorium; it, too, appeared to emit continuously a gas, capable of discharging an electroscope.

The properties of these gases were first studied by Professor Rutherford and Mr. Soddy, working at that time in Montreal. They found that the gases from thorium and from radium could be condensed if they were cooled to a low temperature by means of liquid air; they also discovered that no chemical agent, even of the most active nature, such as red-hot magnesium, or oxygen at the high temperature of the electric discharge, is able to alter the gas or to destroy its radio-active power.

I propose to-night to describe some of the other properties of this gas, which I have recently been studying; and I am fortunate, owing to the kindness of the Vienna Academy, which has placed a relatively large quantity of radium in my hands, in being able to illustrate my lecture on a scale up till now impossible.

A little glass bulb, containing the radium salt dissolved in water, is sealed to the intake

tube of a mercury pump, which allows of the extraction of the gas from the bulb and its collection. The radium decomposes water into hydrogen and oxygen, its constituents; and, although the volume of the emanation, the special gas produced by the radium, is so small that it could not be collected alone, there is no difficulty in extracting the gases into which it is mixed and with them the emanation itself. Moreover, there is no difficulty in separating these gases, because, as is well-known, they are explosive; and when a spark is psssed they combine to form water, leaving the emanation unaffected.

I have here some of these mixed gases. I will introduce them into a tube, little by little, and making the room dark, they become visible, owing to the luminosity of the products into which the emanation changes. They will then be exploded. The residue is very much brighter, owing to its greater concentration. On opening a stopcock, which connects the little explosion vessel with a long spirally wound glass tube, their passage along the tube can be seen. A plug of wool in the tube delays their passage somewhat, showing that it suffers friction in passing through the wool. At the end of the spiral is a large glass vessel containing some willemite—a variety of silicate of zinc—which is particularly sensitive to the rays evolved by the disintegration—products of the emanation; and when the emanation reaches it, it will glow, and in course of time, the luminosity will increase, owing to the progressive change of the emanation. Its more active products are very short-lived; their motto is "a short life and a merry one," like ephemeræ; and in the course of a few hours they are disappearing as such at the same rate as that at which they are being formed; hence the brilliancy of the willemite will increase for a few hours, and will then remain constant for a long time, because these products are present, after a few hours, in their maximum amount.

Before stopping this experiment, or rather, series of experiments, let me cool a glass vessel in direct connection with that containing the willemite, by means of liquid air. This condenses the emanation, and in all probability freezes it. It is thus almost wholly withdrawn from the bulb containing the willemite. On shutting a tap between these two bulbs, the emanation remains in its prison, and can be removed. This bulb now glows brightly.

These experiments may give you some idea how it is possible to manipulate this curious gas, transfer it from place to place, and examine its properties. It can be transferred in a pure state to a "vacuum-tube," and its spectrum can be examined. Let me show you first a stencil of the spectrum of radium, its father. This shows several red lines, and in its general character resembles that of strontium, one of the series of metals to which radium belongs. [The flame of strontium was then exhibited.]

I cannot show you a similar experiment with radium; it would lose that precious substance, and what is of less importance, would cost about £10, for radium of about that value would be irretrievably lost. Hence you must take strontium as a substitute. A tube, called a Plücker's tube, containing the emanation from radium, also gives a spectrum, a stencil representation of which I now throw on the screen.

On keeping such a spectrum tube for a week, a new spectrum begins to appear. It is that of helium, one of the argon series of gases. Here is a specimen of helium extracted from a mineral named clevite, which emits a brilliant yellow light when stimulated by a current of high-tension electricity. Its spectrum, exhibited as a stencil, shows a bright yellow line, named D_3, together with many others. Both emanation and helium pass for elements, *i.e.*, substances of a simple nature, which cannot be regarded as compounds in the ordinary sense of the word like water, or like common salt. But I am often asked: "How can an element remain an element if it changes into another?" The answer is: "There are degrees in the elementary scale as there are degrees in the stability of compounds." For example, rock-crystal is generally regarded as a very stable compound, because it is not decomposed by almost any high temperature. Yet it is perfectly well-known that it consists of silicon and oxygen; or perhaps one should be more cautious and say one knows that when silica and oxygen are heated together, silica or rock-crystal is formed; and from silica, silicon and oxygen can be obtained. Contrast its permanency with that of, say, nitro-glycerine, the chief constituent of dynamite, shattered by the least concussion. Different compounds, then, have different degrees of stability. And what we name elements are in all probability, only enormously stable compounds. But not all compounds are stable; and not all elements, apparently. When a

mixture of oxygen and hydrogen explodes, a compound is formed, namely water, and a relatively great amount of heat is evolved. In this case heat is lost, or given out, by the formation of a compound. But when nitro-glycerine explodes, it becomes less complex; it changes into simple compounds, water and carbon dioxide, and into the element nitrogen, all of which are its constituents. We name those compounds which are formed with evolution of heat, exothermic, or "heat out"; and those which are formed with absorption of heat, endothermic, or "heat in." Water is an exothermic, nitro-glycerine an endothermic, compound.

Now, as you will see, it is probable that elements, if they are really compounds, may admit of similar classification. The emanation, whether it be a compound or not, is certainly enormously endothermic; that is, if left alone, it changes and presumably decomposes, with an almost unrealisable evolution of heat. One gram of radium emits each hour enough heat to raise a gram of water through 100 degrees; and one gram of emanation enough to melt a gram of ice. As this form of statement may not be familiar to many present let me put it in another form. Five and a half grains of radium would boil away a grain of water every hour; twelve pounds would evaporate a pound of water per hour. A ton would boil away 200 lbs. of water each hour, and it would serve as efficient fuel to warm a house, do all the cooking and afford plenty of hot baths for a large family, not only during their own lives, but it would continue to perform these useful functions for about twenty generations without much falling off!

Yet it is not everlasting; it ceases to emit heat because it ceases to change. Theoretically, it will last for ever; but practically, it falls off in the course of a long time to a minute fraction of its original powers. As its theoretical life is infinite, we cannot ascribe a period to it, but we can to its "period of half-decay." An illustration will render this idea clear, though at first it may appear paradoxical. Suppose we take a bar of soap, cut off a twentieth part—an operation which we may suppose takes a minute—and during the next minute cut off a twentieth of what remains, *i.e.*, nineteen-twentieths of the original; during the third minute, nineteen-twentieths of the nineteen twentieths, and so on, diminishing what remains by one-twentieth each minute. It is clear that if the soap is infinitely divisible, we may go on cutting for ever, for it can always be mentally conceived that we can cut off a twentieth of what remains. But it is equally clear that there will come a time when only half the original bar of soap is left. This corresponds to the half-life-period of radium. Without placing a numerical value on this, let me first consider the emanation. Its half-life-period is pretty accurately known; it is very nearly $3\frac{3}{4}$ days. That is, every $3\frac{3}{4}$ days the emanation is half gone. Let us, for simplicity's sake, suppose the figure to be 4 days. Then in 4 days, half the emanation will have changed, and there will be a half left; in 4 days more there will be a quarter left; in still 4 days more, that is 12 days in all, one-eighth will be left; after 16 days, one-sixteenth; after 20 days one thirty-second; after 24 days one sixty-fourth; in 28 days, one hundred and twenty-eighth; so that we may say that after a month what is left is hardly worth counting; less that 1 per cent. is left.

What becomes of it? You have an idea how it is possible to transfer it from one vessel to another; you can conceive that it may be forced up into a narrow tube, in which it can be measured; and that is what Mr. Soddy and I did, and more recently, Mr. Cameron. The last measurements, which I made with Mr. Cameron, are more accurate. Having measured it, we were astonished to find it rapidly contracting, and in about an hour and a half it had come down to half its original volume. Now, we do not know any gas which contracts slowly to half-volume in this manner; but we do know a gas, called nitric peroxide, of which the formula is N_2O_4, which, when heated, doubles its volume, because a molecule of N_2O_4 splits up into two molecular of NO_2; and as equal numbers of molecules inhabit equal volumes, the NO_2 occupies twice the volume of the N_2O_4. And on cooling, the reverse takes place; two molecules of NO_2 associate themselves into one of N_2O_4, and the volume is halved. That is what happens to the emanation. When left alone, it halves its volume, and the presumption is that $2\ Em = Em_2$; two molecules coalesce to one, when heated to 80°C.; it nearly doubles its volume again, and it must be concluded that one molecule becomes two; $Em_2 = 2\ Em$. All this time, however, it is changing its volume owing to another circumstance; it is slowly converting itself into helium—and something else. The "something else" has been called by Rutherford radium A, and that changes quickly into radium B; B is followed by C,

and so on down the letters of the alphabet to F or G. Each of these substances has its own rate of change, and it is thus, chiefly, that each is recognised, as it is certain that no one of them is a gas. We are not concerned with them here; we will leave alone the children and grandchildren of the emanation and consider the parent only.

Radium emanation, then, is changing slowly into helium. That it does so was discovered by the writer in conjunction with Mr. Frederick Soddy in 1903. It has merely to be left alone in a tube by itself or mixed with gases such as oxygen, nitrogen, or hydrogen, and after some time it is replaced by about three and a half times its volume of helium. It is interesting to compare the spectra of these gases. [The spectrum of the emanation was then projected on the screen, and afterwards that of helium; a Plücker tube filled with helium from mineral sources was then caused to emit light by a high tension discharge; and also a small tube, containing helium produced by the decay of the emanation.] They are wholly different, and each is easily recognisable.

The emanation, as already remarked, evolves heat; during its change, it parts with a relatively enormous quantity of energy. If dissolved in water, it produces another effect, also evolving a loss of energy; it decomposes the water into oxygen and hydrogen. It is possible to do this by a very high temperature; when steam is heated to whiteness, it is decomposed thus. It is also possible to effect the decomposition of water by an electric current; but as pure water hardly conducts electricity, some salt must be added to the water. With emanation, however, pure water, the purest attainable, is thus decomposed. There is always a small excess of hydrogen, over that required to combine with the oxygen; and one hypothesis to account for this excess is that hydrogen, too, may be one of the products of the decay of the emanation. But, on the whole, that is unlikely. There is formed at the same time a trace of dioxide of hydrogen, a liquid richer in oxygen than water, and that may account for the small excess of hydrogen, although, so far as I can judge, not wholly.

It was while carrying out experiments on this curious decomposition of water that in conjunction with Mr. Alex. Cameron, who was assisting me, I discovered that the gases then obtained contain a mere trace of helium, and that on removing the oxygen and hydrogen, there is left neon, another of the inactive atmospheric gases which Dr. Travers and I discovered in 1898. I cannot show you a sample produced from the emanation in presence of water, but I show the spectrum of a sample extracted from air, and also the light from a Plücker tube containing neon. It cannot be mistaken for helium, and the gas from the emanation plus water yielded as fine a spectrum as the one which you see.

With the hope of accounting for the excess of hydrogen, I exposed a solution of sulphate of copper to the action of the emanation; and the gases evolved contained argon, but no recognisable helium or neon. And some of the copper, too, appeared to have changed; for the residue of the liquid, after removing all copper from it, contained a small trace of the element lithium, a member of the sodium group. Lithium, too, is easily recognised by its spectrum; it gives a brilliant crimson colour to a flame, and its spectrum contains a brilliant red line, of which the position is well-defined and not mistakeable for the spectrum of any other element. It is probable, though not yet proved, that the element sodium is also a transmutation-product of copper; because the residue, obtained by evaporating the copper-solution, deprived of copper, which had been treated with emanation, was more than twice as heavy as that obtained from untreated copper sulphate. It must be explained that these solutions were contained in glass bulbs, and that glass contains silicate of sodium; experiments are now in progress in which glass is excluded, for the bulb used is one constructed of silica, free from sodium.

Now these results corroborate each other, in a certain fashion, and admit of a provisional theory. The emanation, as already stated, is a very inactive gas, unattacked by any reagents. This is the characteristic of the argon group alone, namely, helium, neon, argon, krypton, and xenon. Again, we know a similar series, though a longer one, the first member of which is lithium, and the second sodium, to which copper, silver, and gold also belong. It appears possible, to say the least, that the emanation degrades, splits, is transformed, or transmutes itself into helium, neon, or argon, all members of the same natural group, according to circumstances; and that similarly, copper under the enormous influx of energy brought to bear on its atoms, may turn into lithium, sodium, and potassium, all of which have smaller atomic weights than copper, and all of which are usually classified

in the same group. Some confirmatory evidence has already been obtained, which would appear to indicate that thorium, which also emits an emanation, is degraded by its energy into carbon, which appears as carbon dioxide in the experiments which I have made. All the results, however, not only need confirmation, but also extension, before any satisfactory theory can be propounded as to the relationship which undoubtedly exists between the properties of the atomic weights of the bodies which we have been accustomed to term elements.

The CHAIRMAN (Sir Steuart Bayley), in proposing a hearty vote of thanks to the lecturer, said that, speaking for himself, he was born in a pre-scientific age; but after listening to the lecture, and watching the experiments, he had been able to appreciate, to a certain extent, not only the labour which had gone to verify all the facts, but the genius which had gone to bring the facts together, and the splendid philosophic imagination which had enabled the lecturer to find the laws which lay behind. To him, personally, the lecture had been the very poetry of science, and he had no doubt that to those who, like himself, were laymen, it had given the same intellectual pleasure, while to those who were scientific students the intellectual enjoyment must have been greater still.

The vote of thanks having been carried unanimously,

Sir WILLIAM RAMSAY, in acknowledging the compliment, said it had given him great pleasure to tell the audience something of the history of the researches in which he had been engaged, and he hoped to have another opportunity later on to tell them some more.

CURRICULA OF SECONDARY SCHOOLS.*

The Committee submit for consideration the following conclusions which they have reached as the result of their debates:—

1. There is need for secondary schools of different types, with different curricula or combinations of curricula: because (*a*) all boys are not suited to the same course of study; (*b*) the requirements of the various callings upon which the boys will subsequently enter differ considerably; (*c*) the needs of the schools differ in a considerable degree according to the economic conditions of the districts in which they are situated. Broadly speaking, however, the secondary schools fall into two different types—viz., those in which the majority of boys remain till eighteen or nineteen, and then continue their education at places of university rank; and those in which the majority leave at fifteen or sixteen and proceed to business. There is, however, no sharp line of demarcation between the two.

2. The Committee consider that one modern foreign language should in all cases be begun at an early age; but are of opinion that it would be a wise educational experiment to postpone the *systematic* teaching of Latin as an ordinary school subject till twelve years of age, and that such a change will prove sufficiently successful to warrant its adoption. On the other hand, they are of opinion that such absence of *systematic* teaching by no means precludes its *incidental* teaching before the age of twelve by such means as will naturally occur to a fully qualified teacher of young boys. The Committee also desire to record their opinion that the continued teaching of either of the two dead languages to boys who after serious trial have shown little or no progress in, or capacity for, such linguistic study has little or no educational value; and that, though the mental training afforded by such study is of great value in the case of many boys, yet in the case of others such study not only produces no good results, but does positive harm to their mental and moral progress by reason of their incapacity to grapple with its difficulties. The Committee go further, and express their doubt whether the authorities in some secondary schools have sufficiently recognised this fact or have provided sufficient alternatives to such linguistic study.

3. The Committee deprecate any form of early specialisation in the education of children, and therefore regard with grave concern the fact that the entrance examinations at the great English public schools give undue prominence to the study of Latin (and Greek) in the course of education at the preparatory schools, the result being that too little time is available for (*a*) the teaching of the mother tongue, (*b*) manual training, (*c*, science and mathematics.

4. The Committee would deprecate anything like State-imposed rigidity in the organisation and studies of secondary schools. But the Committee are led to the conclusion that up to twelve years of age there might be a broad general course of education for all. It would in all cases include careful preliminary training in the use of the mother tongue, so that it could be used in speaking and writing correctly on ordinary occasions, and would further comprise the following divisions:—I. Literary. II. Mathematical. III. Scientific. IV. Manual training. They consider that a school week of twenty-six hours might be divided as follows:—Literary work, thirteen hours; mathematical and scientific work, nine hours; drawing and manual training, four hours; while for those who after twelve years of age commence the

* Report of a Committee of the British Association, consisting of Sir Oliver Lodge (chairman), Mr. C. M. Stuart (secretary), Mr. T. E. Page, Professors M. E. Sadler, H. E. Armstrong, and J. Perry, Sir Philip Magnus, Principal Griffiths, Dr. H. B. Gray, Professor H. A. Miers, Mr. A. E. Shipley, Professor J. J. Findley, and Sir William Huggins.

study of Latin the division of time should be :—Literary work, sixteen hours; other subjects, ten hours.

5. The Committee are of opinion that the curriculum in secondary schools suffers gravely from the number of subjects which have been crowded into it, and they regard this as the most serious factor in secondary education at the present time. They are of opinion that this "overcrowding" is due to two causes :—(1) the disproportionate amount of time bestowed in many schools on the two ancient languages, which leaves only a small residuum for each of the other subjects now increasingly regarded as essential items of education, the result being that the pupil obtains only a smattering of the knowledge of such subjects; (2) the ill-founded belief that the curriculum should be an abstract of all modern knowledge.

6. The Committee desire to see a great simplification in the arrangement of examinations for secondary schools, and they strongly recommend that examination and teaching should go hand in hand, the examiners co-operating with the teachers and acting in conjunction with them in order to further the interests of real education. The Committee would urge upon the universities and professions to accept as qualifying for entrance the leaving certificates granted by each university to the schools which submit to its inspection. The aim should be to examine in accordance with the teaching, and to pay special attention to the special peculiarity of each school, or group of schools; and it would be a great relief, and at once improve the teaching of the higher forms, if the results of such examination were accepted by universities and professional bodies without further entrance test. The Committee particularly deprecate any uniform or centrally administered examination applied to all the schools of the country. For a uniform State examination, if it were made the door of entrance to all higher courses of study and to the professions and Civil Service, would do much evil, focussing the efforts of teachers and pupils upon those parts of the school curriculum in which alone examination is possible. Further, the rivalry between schools would cause the standard of attainment steadily to rise, until the overpressure became serious, and intellectual vigour and independent thought were killed.

7. The Committee feel that no scheme of secondary education can be satisfactory unless it is carried out by teachers of learning and force of character, and they would urge that every effort should be made, by conditions of appointment, by scale of salaries, and by retiring allowances, to attract a high class to the teaching profession, which should be regarded as a very laborious, but very honourable, form of public service. Prompt action in this matter is urgent and imperative; for, unless something is done without delay, the best interests of the schools, and especially of boys' day-schools, will be sacrificed to a false and disastrous economy.

THE COTTON INDUSTRY IN BRAZIL.

The reported consumption of cotton by the Brazilian mills two years ago was approximately 32,000 tons. According to the figures now given for the numbers, size, and output of the factories, this home consumption probably has reached considerably over 50,000 tons. The exports of raw cotton, according to the Brazilian trade returns, were 31,698 tons in 1906. Apparently Brazil's cotton production at present, therefore, is something over 80,000 tons. Practically all of the production of Minas Geraes and Sao Paulo is consumed in those States. The exports of raw cotton are almost enirely from the northern States. What the potential cotton production of Brazil may be, is beyond calculation. Its present cotton-producing area, according to a recent report of the American Consul-General at Rio de Janeiro, covers the greater portion of the settled country, ranging from close to the Amazon to the extreme southern limits, probably about 1,800 miles in a north and south line. The present range east and west is comparatively narrow, but there appears to be no reason why this should be the case, and this fact illustratres the immense cotton-producing possibilities of the country. At present there is very little effort to cultivate cotton upon the basis of modern agriculture. Most of the cotton produced in Brazil is obtained from plants planted in the crudest manner, and with little or no cultivation, from which the staple is taken season after season, until the plant, and the soil supporting it, are worn out. There is then a new planting and the process is repeated. A cotton ginning expert who has investigated the cotton situation in several of the States, has reported that while there is wide variation in the qualities of cotton taken, the length of the staple, its coarseness and fineness, and in other matters affecting the quality, all of it is distinguished by being very much weaker than the same length and thickness of staple grown in the United States. This expert is of opinion that this weakness is due to a deterioration of the staple while the ball is maturing, the deterioration being due to the hot, damp climate, but whether this can be remedied, is yet to be seen. There is little development in the manner of handling the cotton grown in Brazil, in its packing, and in getting it to the mills. The manufacturing industry, as a whole, is carried on at great distances from the source of supply of the raw material, and the transport charges are so high, that in almost any other country it would make the development of the industry impossible. There is a movement among some of the more advanced cotton producers to put the production of the staple upon a more economical basis. Up to the present, however, there has been great uncertainty as to the profits in cotton growing. Men have grown cotton chiefly when there was no other and more profitable crop in sight. The uncertain nature of the business has kept them from investing any more capital than has been absolutely necessary. The development of the

cotton manufacturing industry of Brazil to its present proportions, however, has done away with most of this uncertainty. Cotton growing in Brazil has come to be a safe, profitable, and promising investment, and modern methods will, it is said, soon be introduced. Three-fourths of the general industrial machinery imported into Brazil come from Great Britain. About two-fifths of the remainder come from Germany, and the balance is divided about equally between the United States and France. This proportion covers not only mill machinery, but also ginning and field machinery. In a climate where dampness is likely to affect the size and condition of parts, and especially where almost all kinds of wood are a prey to innumerable insect pests, it is advisable to have all machinery, as far as possible, of metal. The British and other European manufacturers have learnt this, and their cotton machinery is constructed accordingly.

INSURANCE COMPANIES IN JAPAN.

Insurance companies, on the European system, were first organised in Japan in the year 1881, but for some years subsequent thereto, there were no regulations for the supervision of these companies. The Commercial Code, which was promulgated in March, 1890, contained detailed provisions for the conduct and supervision of insurance business, but as that Code had to be revised before it could be brought into operation, the provisions in question never came into force in their original form. In March, 1899, the present Commercial Code was put into operation, and this, amongst other things, lays down the law respecting insurance contracts, and was followed in the ensuing year by the Insurance Business Law, which provides for the control and supervision of insurance companies. Insurance business under this law, may be carried on either by a joint stock company, or on the mutual system. In either case special permission is needed for the establishment of the business. The capital of a joint stock insurance company, and the fund of a mutual insurance company, must be not less than £10,246, and such companies are not permitted to engage at the same time in any other business in addition to that of insurance. Special regulations were issued by Imperial ordinance in 1900, for the supervision of foreign insurance companies so far as concerned their business in Japan. Insurance has been making very rapid progress in Japan, and although the business was to some extent affected by the outbreak of the war with Russia, yet in consequence of the successive Japanese victories on land and sea, and the favourable economic condition of the country, it gradually recovered its former prosperity. According to the latest returns — those for 1905 — there were then 34 life insurance companies, 19 fire insurance, and 3 marine insurance companies in Japan.

HOME INDUSTRIES.

The Cotton Trade Dispute.—The armistice arrived at when it was agreed to obtain from the Law Officers of the Crown an interpretation of the clause of the Brooklands agreement relied on by the masters, has been followed by settlement of a dispute which at one time threatened a general strike of cotton operatives. The dispute concerned in the first instance some ten thousand operatives engaged in spinning fine counts at Oldham, but the complete organisation of both employees and employers in the cotton trade made it possible for the local dispute to lead to a general war. The operatives were the first to move. They contrasted their earnings with those for similar work in other towns, and demanded rises amounting in some cases to 24 and in others to 12½ per cent. in the prices paid them. The employers answered that whatever the merits of the clause, it was barred by a clause in the "Brooklands Agreement," by which the general relations of the two parties are governed. Their contention was that no claim for an advance or reduction of wages could be made until the expiration of twelve months from the previous advance, nor could it exceed 5 per cent. The operatives denied the application of the clause to their present demand, contending that it referred only to proposals for a general advance or reduction, not to those for local changes. The employers refusing to alter their views, the men gave in their notices. Fortunately at the last moment the President of the Board of Trade intervened, and suggested that the opinion of the Law Officers on the clause should be obtained, and that meantime the spinners should return to work. This was agreed to, and the Law Officers found that whilst in the particular form in which it was made the operators' demand was an infringment of the Brooklands agreement, the infringement was more in the form than in the substance of their application, and that it might have been possible to pursue substantially the same end in some other way that would have been technically unexceptionable. This finding left the Employers' Federation free to break off negotiations, but they took what will be generally considered the wiser course and renewed negotiations which have ended in a compromise acceptable to all. The official report of the settlement is in terms too technical to be understood by those outside the trade, but it may be said that the agreement come to will benefit some 4,000 operatives in the Oldham district, whereas the advance first sought by the operatives' officials affected only 844 of their members. The extension of the number benefited by the grant was due, it is understood, to the compromise suggested by the employers who said that had they granted what the operatives demanded as a final means of settlement, namely, an advance of 10 per cent. for spinners of 60's counts and above, twist and weft, one grievance would have been met only to haste another, seeing that the spinners of medium and coarser counts would have forthwith demanded more generous treatment. As it is 4,000 operatives will receive an average advance

of $4\frac{1}{2}$ per cent. in wages. Thus agreement has been marked by mutual concessions. The operatives get less than the spinners of 60's counts and above demanded, but it is estimated that the concession will cost the employers £1,000 a week more in wages than would have been the case had the original proposal been accepted.

The Progress of the Turbine.—A turbine liner, *Heliopolis* (12,000 tons, 18,000 h.p.), built for service between Marseilles and Egypt, is an indication of what may be expected in the way of turbine development in the mercantile marine in the early future. First there was the cross-channel to France experiment, then it was seen on the trans-atlantic route, and in the run between the Clyde and Ireland, now it is to be in the Mediterranean. Soon it will be on every sea. The *Heliopolis*, and her sister ship now building by the Fairfield Shipbuilding and Engineering Company, are to be run in connection with express trains from London to Cairo, and are expected to reduce the journey by a day and a half. These vessels have three propellers, the central one driven by a high-pressure turbine, and the other shafts by low-pressure turbines. The use of more than one screw on a shaft has been abandoned since it was proved that the after screw, working in water broken by the first screw, loses much of its power, and the modelling of the hull has been modified to lessen the strain of the water affected by the side screws thrusting against the ship, and causing vibration. It is said that the coal consumption of the *Heliopolis* is under 250 tons per day's steaming, or only 1·25 lb. per hour per horse-power. It will be a very important matter for shipbuilders if shipowners are convinced that turbine steamers can be propelled more economically as well as faster in proportion to size than the old class of steamers now on the water. The present stock of ships is in excess of the demand, and the immediate outlook for the shipbuilder is anything but bright. But if the commercial advantages of the turbine can be demonstrated, shipowners will be tempted to new ventures in the way of constructive power sooner than otherwise would be the case.

The Yield of Crops.—The fourth and final part of Volume XLI. of the Annual Agricultural Statistics has just been issued by the Board of Agriculture and contains some interesting tables giving international crop comparisons, and bearing upon wheat area and cultivation. A comparison of the yield of crops in different countries must be accepted with reserve since comparatively few crops are common to all countries alike, and those, such as wheat, which are most general, occupy very diverse positions in the rural economy of the various nations. As the report points out it is somewhat misleading to compare the average yield of 16,000,000 of acres of wheat land in France, or of 47,000,000 acres in the United States with the yield of 1,750,000 acres in the United Kingdom. It is to be expected that as the area under a particular crop is reduced the yield per acre tends to increase by the elimination of the less suitable land. But when due allowance is made for this the yield per acre of wheat, barley, and oats in the United Kingdom compares very favourably with that of all Continental countries for which the figures are given, with the exception of Holland and Belgium. The average yield per acre in the United Kingdom is 33·7 bushels, and this is exceeded only in Holland, where it is 34·1, and in Belgium, where it is 34·. The same two countries exceed the United Kingdom in their yield per acre of oats and barley. In oats the United Kingdom yield is 42·4 bushels, that of Belgium 53·3, and of Holland 53·0; whilst of barley the United Kingdom gives 35·0 bushels, Belgium 48·4, and Holland 44·6. The yield of wheat in France is as low as 19·7, Germany being 30·3.

Wheat Area and Population.—It has been asserted of late with some confidence that the population of the world is already pressing seriously upon the means of subsistence as reckoned in bread stuffs, but the Agricultural Department in their present report submit figures which have satisfied them that "it may at any rate be said that they (the figures) do not appear to suggest any imminent risk of a serious shortage in the world's wheat supply other than that arising from temporary causes." Taking a rough survey of 25 years it appears that in thirteen European countries, for which figures are available, the acreage under wheat has increased since 1881 by 22 million acres, or 28 per cent., while population has increased by $74\frac{1}{4}$ millions, or 26 per cent. It may be said that the consumption per head has altered, and therefore it is very difficult to draw deductions. Upon this, the report says that altogether the consumption of wheat per head in some countries is probably decreasing owing to a higher standard of living introducing a more varied dietary; in other countries it is increasing from the same cause, operating at an earlier stage of economic development, and resulting in the substitution of wheat for rye or other bread corn. The net result of the figures given is that on the whole the wheat areas in the thirteen European countries, the United States, Argentina, Canada, and Australia has increased more rapidly than population, and that whereas twenty-five years ago there were 283 people (more or less wheat eaters) for every 100 acres of wheat there are now 264 persons for the same total of wheat-growing land. It is only in the United States that population appears to be overtaking the wheat acreage rapidly. During the past quarter of a century the population of the United States has increased by 34 millions, or 68 per cent., while the wheat area has increased by less than 10 million acres, or 25 per cent.

Railway Co operation.—The proposed "working arrangement" between the Great Central and Great

Northern railway companies is the most noteworthy development in the home railway world since the similar arrangement brought about between the South-Eastern and Chatham companies some years ago. It cannot be said that from the shareholders' point of view the arrangement between the Kentish companies has fulfilled expectations, but if hitherto they have gained nothing the travelling public have benefited by improved services provided by a large capital expenditure which would have been impossible but for the working union. In Scotland greater economy in capital and revenue expenditure has improved the position of shareholders, and there is general admission that English railway shareholders have suffered by squandering on reckless competition. The gross receipts of all the leading railways are satisfactory, but extra expenses and capital charges have grown at a still more rapid rate. Directors attribute this extra expenditure to higher rates of wages, increased rates and taxes, the advance in the price of coal, &c., but unwise competition has had not a little to do with it. The working arrangement between the Great Northern and Great Central—rendered possible without going to Parliament by the Agreement of 1858—will be the most effective means of stopping such competition between these two companies, and can hardly fail, therefore, to commend itself to shareholders. Of course, the interest of shareholders and the public are not always the same in these matters, but in the present case, whilst the Midland and North Western lines are wedged in between the Great Northern and Great Central systems there can be little fear of competition being abolished altogether from among the Northern Group, or of the public convenience suffering from the proposed arrangement.

Motor Lorries—The use of heavy motor lorries appears to be on the increase especially in Lancashire. The makers of these vehicles report not only that orders are increasing, but that many of them are "repeats." A motor lorry costs about £600, and the cost of operation, including depreciation and repairs, is between £250 and £300 per annum, the fuel costing only from 10 to 20 per cent. of this sum, so that no great saving in the operating expenses is possible by allowing the motor to stand idle part of its time. Then, again, owing to its great weight, the roads upon which a motor-lorry travels must be good, otherwise it may damage both the road and itself, and get stranded during bad weather. It is obvious, therefore, that the substitution of motor-lorries for horses and waggons, or for the goods train, must be slow and at most partial, but where the conditions are favourable, that is to say, where it can operate on good roads and get full loads of heavy goods both ways to cover considerable distances, it can be used with much advantage as compared with the horse-drawn lorry. A motor-lorry travels at about double the speed of a horse lorry, but capital and wages charges make it imperative that it shall be fully employed.

GENERAL NOTES.

Electrical Exhibition at Marseilles, 1908.—An International Exhibition of Application of Electricity will be opened at Marseilles on the 19th of April, 1908, and will continue until the 31st October. The town of Marseilles, recognising the great utility of this undertaking, has placed the park of the Rond Point du Prado at the disposal of the committee. This park, with a superficial area of 60 acres, and which was, in 1906, the site of the successful French Colonial Exhibition, lends itself in every way to the object in view by reason of its facility of access and its grand palace. The existing buildings will be supplemented by a number of new ones, and every desirable extension will be given to the space and requirements of the Exhibition. Public entertainments, with luminous fountains, &c., will be frequently held, and a large section of the Exhibition will be devoted to all kinds of amusements, including daily concerts, theatres, and open-air spectacular entertainments. There will also be special exhibitions of horticulture, art, automobilism, &c., as well as scientific and other congresses and lectures. The Exhibition will contain the following sections:—(1) Transmission and distribution of electrical energy; (2) applications of electricity to industries in general; (3) to domestic industries; (4) to domestic economy; (5) to public and private lighting; (6) to heating and ventilation; (7) to machinery for lifting and manipulation; (8) to mines and quarries; (9) to traction; (10) to agriculture; (11) to military and naval engineering; (12) electric chemistry, electric metallurgy, and the allied sciences; (13) telegraphic and telephonic appliances; (14) applications to the medical and surgical sciences; (15) electrical instruments for measurement and calibration; (16) raw materials and manufactures used in electrical industries; (17) practical and theoretical teaching of the science of electricity.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

December 18.—"Le Rôle de la France en Afrique Occidentale." By Monsieur Lucien Hubert, Député des Ardennes. The author will read his paper in French. Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., will preside.

Applied Art Section.

Tuesday evening, at 8 o'clock:—

December 17.—"How to Make the Most of a Museum." By Lewis Foreman Day, F.S.A. Sir Aston Webb, R.A., F.R.I.B.A., will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Conrad Beck, F.R.M.S., "The Theory of the Microscope." Four Lectures.

Lecture IV.—December 16.—*Applications of Theory.*—Best combination of eye-piece and object-glass—High power illumination — Gordon's oscillating screen—Useless aperture—Penetration for visual and photographic work—Effect of cover-glass—Substage condensers—Achromatism and aplanatism in condensers—Angle of illuminating cone—Illuminants—Monochromatic light—Wright's experiments—Critical illumination—Possible advances.

The Lectures are illustrated by Lantern slides and Experiments.

Juvenile Lectures.

Two Lectures suitable for a Juvenile audience will be delivered on Wednesday afternoons, January 1 and 8, 1908, at 5 o'clock, by F. Martin Duncan, on "The Scientific Applications of the Cinematograph."

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Conrad Beck, "The Theory of the Microscope." (Lecture IV.)

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. A. H. Harrison, "In Search of an Arctic Continent."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. Woodward, "Means of Escape from Fire in Modern Factories and Warehouse Buildings, with reference to the London Buildings Acts Amendment Act."

Actuaries, Staples-inn-hall, Holborn, W.C., 5 p.m.

Alpine Club, 23, Savile-row, W., 8½ p.m.

Tuesday, Dec. 17 SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Lewis Foreman Day, "How to Make the Most of a Museum."

Asiatic, 22, Albemarle-street, W., 4 p.m. Mrs. Bullock-Workman, "Ascents in the North-West Himalayas."

Faraday Society, in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W., 8 p.m. 1. Dr. F. G. Donnan, "A Physico-Chemical Study of the Complex Copper-Glycocoll Sulphates" (by J. T. Barker). 2. Dr. F. Mollwo Perkin, "The Centenary of the Discovery of the Alkali Metals by Davy: the Industrial Developments of the Discovery."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Sir Whately Eliot, "Keyham Dockyard Extension." 2. Mr. George Hall Scott, "Keyham Dockyard Extension: Temporary Works, and Plant and Appliances used in Construction."

Statistical, 9, Adelphi-terrace, W.C. 5 p.m. Mr. Robert J. Thompson, "An Inquiry into the Rent of Agricultural Land in England and Wales during the 19th Century."

Photographic, 66, Russell-square, W.C., 8 p.m. Dr. C. E. Mees and Mr. S. H. Wratten, "Plates Sensitised with Di Cyanin and the Photography of the Infra-Red."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Wednesday, Dec. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Monsieur Lucien Hubert, "Le Rôle de la France en Afrique Occidentale."

Meteorological, 25, Great George-street, W., 7½ p.m. 1. Captain C. H. Ley, "The Possibility of a Topography of the Air based on Balloon Observations with Special Theodolites." 2. Mr. Richard Strachan, "Indications of Approaching Frost."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. James Murray, "Some African Rotifers." 2. Mr. E. M. Nelson, "Gregory and Wright's Microscope" and "A Correction for a Spectroscope." 3. Mr. E. Large, Exhibition of Selenite Specimens, showing Interesting Features due to Twinning.

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4½ p.m. Mr. C. A. Birtwistle, "Cotton Growing and Nigeria."

Thursday, Dec. 19...Linnean, Burlington-house, W., 8 p.m.

Optical, 20, Hanover-square, W., 8 p.m. 1. Demonstration of Autochrome Colour Photographs by Mr. J. McIntosh. 2. Mr. Harry L. Taylor, "The Effect of Distance on High-Power Sphero-Cylindrical Lenses." 3. Exhibition of Vacuum Tubes by Mr. Francis A. Darton.

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. H. Henderson, "Electrical Power in Railway Goods Warehouses."

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m. Dr. C. Cotton, "The Bardon Papers as a Source of Information for the Impeachment of Mary, Queen of Scots."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. J. C. Irvine and A. M. Moodie, "Derivatives of Tetramethyl Glucose." 2. Mr. J. Hübner, "The Characterisation of Mercerised Cotton." Preliminary Note. 3. Messrs. A. Senier and P. C. Austin, "Attempted Synthesis of $\begin{array}{c}\beta\text{—N—}\beta\\ \vert\\ \beta\text{—CH—}\beta\end{array}$ dinaphtharcridine: Condensation of Methylene Dichloride and 1—substituted—2—Napthylamines."

Friday, Dec. 20...Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. L. G. E. Morse, "The Mechanical and Thermal Efficiency of a Petrol Engine."

North-East Coast Institute of Engineers and Ship-builders, Westgate-road, Newcastle-on-Tyne, 7½ p.m. 1. Mr. W. G. Spence, "Notes from Four Years Working of the Educational Committee's Recommendations." 2. Mr. H. R. Jarvis, "Floating Docks."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. Arthur Keen, "Wren's City Churches."

Quekett Microscopical Club, 20, Hanover-square, W., 8 p.m.

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Dr. H. T. Ashton, "Notes on the Manufacture and Upkeep of Milling Cutters."

Journal of the Society of Arts.

No. 2,874. VOL. LVI.

FRIDAY, DECEMBER 20, 1907.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

SHAW LECTURES.

On Friday evening, 13th inst., Professor THOMAS OLIVER, M.D., delivered the second Shaw Lecture on "Industrial Poisons: Lead and Phosphorus, with special reference to Lucifer Match Making."

The lecture will be published in a future number of the *Journal.*

CANTOR LECTURES.

Mr. CONRAD BECK, F.R.M.S., delivered the fourth and last lecture of his course on "The Theory of the Microscope," on Monday evening, 16th inst.

A vote of thanks to Mr. Beck for his course of lectures was carried unanimously, on the motion of the CHAIRMAN.

The first lecture will be published in the next number of the *Journal.*

APPLIED ART SECTION.

Tuesday evening, December 17; Sir ASTON WEBB, R.A., F.R.I.B.A., in the chair.

The paper read was "How to Make the Most of a Museum." By LEWIS FOREMAN DAY, F.S.A.

The paper and discussion will be published in a future number of the *Journal.*

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience, will be delivered on Wednesday afternoons, January 1st and 8th, at 5 o'clock, by F. MARTIN DUNCAN, on "The Scientific Applications of the Cinematograph."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, December 14; SIR WILLIAM LEE-WARNER, K.C.S.I., in the chair.

The SECRETARY of the Section announced that Lord Harris, who was to have presided was obliged to attend a meeting of his regiment in Kent that afternoon, and was, therefore, unable to take the chair. His lordship expressed his disappointment and regret.

The CHAIRMAN (Sir William Lee-Warner), in introducing the reader of the paper, said that to any one from Bombay the introduction of Mr. Gilbert was absolutely unnecessary, but as he hoped there were many present who were acquainted with other parts of India besides Bombay, he would merely state that the author was well known in Western India, not only as a good sportsman and a sound professional man, but as one of those non-official Englishmen who did so much to help the governing authorities to govern the country, for he always showed the greatest sympathy with the natives, and at the same time was always on the best terms with the officials. His advice had often been sought on matters of moment, not only by Indians, but by official Englishmen.

The paper read was :—

BIG GAME IN INDIA.

By Reginald Gilbert, F.Z.S.

I must preface my remarks by stating that my knowledge of the wild beasts of India does not extend beyond the boundaries of Western India, Central India, and the Central Provinces. Although I have been in the jungles in other parts of India, I have not there come on close terms with the denizens of the forest; and, when I speak of my experiences with big game, I do not wish to pretend to a larger knowledge than I actually possess. The fascination of camping in the jungles of India was to me, in my younger days, as it must have been to hundreds of others, one of the greatest charms of life, and I look back with pleasure to the many happy days I spent there, and with sympathy for the poor, fever-stricken jungle men who accompanied me, whose knowledge of wild beasts and wild nature was to me a continued object of admiration, and whom I looked upon as my mentors. The book of nature had no secrets or mysteries for them. They could quickly read it, whilst I could only slowly spell out the easy words.

Before referring in detail to the big game which form the subject of my paper, I would advert to the essentially modern nature of the literature which deals with the methods of killing them. In all old works relating to travel in India we read of jungles being infested with wild beasts which frequently killed travellers, but until the nineteenth century we find nothing in the books which bears upon the means of destruction employed. Bows and arrows, and crossbows or flint-locks were not tempting weapons for the sportsmen of early days. One ancient mode of sport, the netting of tigers, is still carried on in Mysore, but it seems to have been more or less peculiar to that province, as I can find no trace of it in other parts of India. I shall refer to this very interesting survival of an old sport later on. Meanwhile let me glance briefly at the principal varieties of wild animals that are to be found in the jungles of India.

Disappearance of the Lion.

I will start with the lion. He still exists in one district of India only, viz., the Gir forests in the Native State of Junaghar in Kathiawar. It is due to the fostering care of the chiefs of this State and the British political officers in Kathiawar that the Indian lion is not extinct. This forest, in which he has found what would appear to be his last retreat, favours his preservation. It covers a small area and lies in a corner of India bounded on one side by the sea and cut off on the other from the rest of India by desert and open plains. There are not many survivors and only occasionally are any allowed to be shot. Lions were formerly common in Central India, and have survived there until a comparatively recent period, for I have met sportsmen who have shot them there. H.H. the Maharaja Scindia of Gwalior last year obtained about twenty lion cubs from Africa, and turned them down in a large jungle which he has for years past kept as a preserve for big game. I made inquiries about them when I was in India last year, but they have been turned down for so short a time that it is impossible to prognosticate how they will do in their new home.

The Monarch of the Jungle.

The tiger, as you know, is the king of Indian animals, and is the one most identified with Indian sport. He is found all over the country, and in other parts of Asia. He is able to thrive even in frost and snow, in icy Manchuria, and in the hills of Northern Afghanistan.

There is, I find, a prevalent idea in England that one has only to enter a big Indian jungle to be able to see the tiger walking about, but I need hardly say that he is not so obtrusive as that; and, as a matter of fact, it is most exceptional to see a tiger, except in a well-organised beat for him. He never moves in the open in the day time if he can help it. I have been singularly fortunate in coming across tigers by chance. The first I ever saw, nearly 30 years ago, were in the Central Provinces, when I was out stalking bison. I was riding, in an open jungle, which had been burnt, with a man behind me carrying my rifle. I saw two large tigers walking about 200 yards ahead in some fairly open jungle. We espied one another at the same time. They stopped and gazed at me. I looked at them, and wondered what I ought to do. I soon got off my pony and loaded my rifle. This had the effect of making the tigers run off as fast as they could, and I saw no more of them. I pugged up a short way, when I came on to a herd of bison, which occupied my attention for that day.

A great amusement of mine was stalking bison in a district on the Satpura Hills that was fairly full of tigers, where they could not be beaten out owing to the country being a vast uninhabited jungle, and where beaters

could not be obtained. I have come on very fresh tracks of tigers repeatedly, and I have heard them moving ahead of me in thick jungle, and even heard them growling, but I could never see them. I have even had them through my camp at night. I once, however, came on five tigers at one time. When camped about 20 miles from the hill station of Mahableshwar, I heard in the early morning a bekri deer on the hill above my camp sounding a note of alarm. I suspected that a tiger was the cause of the deer's fright, but my shikari, who soon came in, saying he could get me no reliable news of tiger, laughed the idea to scorn. Nevertheless in the evening I determined to go for a ride up the hill, and I took with me the man in charge of the mule, and a coolie carrying an unloaded rifle. About half way up the hill, in some scrub jungle, I heard a great bustle and movement of boughs just below. I looked, and saw a number of tigers moving off. I got off my mule, loaded my rifle, and fired at one moving slowly away. As soon as the shot was fired several tigers taking alarm made a spring out of the scrub and rushed off. The jungle seemed in my excitement to be alive with tigers. I missed both barrels. I turned to the muleteer and asked him how many tigers there were. He replied, twelve. I asked the coolie the same question. He replied, ten. I could not myself determine how many there were, but I thought it possible there were seven or eight. However we were all wrong. I beat for these tigers for several days, and the beaters saw them often. There were five. I only got one of them. If I had had a companion with me I should have done better, for the jungles were too large for one gun. On another occasion a friend and I found ourselves in thick jungle, where we had gone to see a dead sambar killed by a tiger on the previous day. We heard the tiger move off, and we came on to a small herd of sambar, to which we were attracted by hearing the stags barking. We got close up to and amongst them, but they took no notice of us, and we felt sure that they were alarmed by a tiger. The jungle was thick, and we hoped that by standing still we might see the object of this terror. After waiting some time and not seeing it, I told my friend to fire at a large stag. He wounded it, and our time was occupied in its pursuit. We came back later, and had tiffin and a rest at a stream close by. Next day we returned, and our shikaris pointed out the place where the tiger had taken his siesta the previous day. It was within 50 yards of where we had taken ours.

MAN-EATERS.

Man-eating tigers and their characteristics have always been of interest to me. Nearly 20 years ago I made a special investigation of the subject, and obtained a great deal of information which I embodied in some papers contributed to the Bombay Natural History Society. I was anxious to know whether there was any special reason for the tiger taking to human food, and if he had any proclivities which distinguished him from his game-killing brother. There was a theory widely held in India that tigers in their old age took to man-killing, when they were decrepit and too inactive to kill game, and that man-eaters were always emaciated and mangy.

The evidence I collected showed that this theory was quite incorrect. I found that man-eaters had for years existed in certain districts, which contained plenty of natural food for tigers, and that in other localities infested by tigers, man-eaters had never been heard of. I visited the haunts of man-eaters, and went to the actual spots where men had been seized, and obtained evidence from various witnesses. The only theory I could put forward was that the man-eater inherited the vice, or that the parent, having previously learnt it from a parent or companion, taught the cubs to kill human beings, such cubs when grown up, teaching their own cubs or their mates, and so perpetuating the practice in that district. In short, that the tiger is sometimes born a man-eater, and sometimes taught to be one. This assumption would account for some districts never being entirely free from man-eaters.

Let me tell of one or two man-eaters of evil fame. In 1889 a man-eating tigress appeared on the Bengal-Nagpur Railway, and her predilection was feasting on the *employés* of the line. For a long time she hunted within an area of nine square miles contiguous to the railway, evincing great cunning and audacity, as many of the gang of permanent way men knew full well. She would snatch them up and carry them a considerable distance. All I need say about her was that she met the fate she deserved.

The "Jaunsar man-eater" was another notorious tigress whose evil deeds were often recorded in the Indian newspapers some years ago. She was best known from the fact that she carried off a European, who, with Mr. B.

Osmaston, of the Indian Forest Department, was seeking for her near Chakrata in the Himalayas. Mr. Osmaston killed her whilst she was worrying his companion. It is only right that I should state out of respect to this tigress's memory that she received some provocation, because these two gentlemen went up in broad daylight to a buffalo that she had previously killed, and she may well have supposed that they intended to carry off her dinner. I had a very interesting adventure myself with a man-eater, but this, perhaps, is of more interest to myself than to others and I am not here to tell tiger stories. Besides, is it not all written in the chronicles of the Bombay Natural History Society?

I will, however, give you some particulars relating to a notorious man-eater, which was killed as recently as September, 1906, in the Central Provinces by Mr. E. A. Guest, Deputy Commissioner of Sambalpur. I had heard of the depredations of this animal and also of its being killed. I, therefore, wrote to Mr. Guest for an account of it, and I now give you the story in his own words:—

"On the 19th September," Mr. Guest writes, "I shot a notorious man-eating tigress, which had been at large for five years since 1901, and for which the Central Provinces Government had offered a reward of Rs.500.

"Contrary to my expectation the tigress had a beautiful coat, and I believe that a famous Indian shikari, Captain Shakespear, mentions in a work that he shot a man-eating tigress with a very fine coat. This puts an end to the general idea that such a beast is mangy.

"The tigress measured 8 feet 7 inches, and was very thick set, with heavy paws, resembling those of a large tiger I shot in February, but in all respects she was like an ordinary tiger. I might note that she had one large lower tooth, slightly broken, perhaps by a blow from one of her victims or one of the persons who escaped from her. She was a terror to the villagers attached to two police out-posts in British territory, and besides she had a wide range in Sarangarh Feudatory State, which adjoins this district. From the resolutions of the Central Provinces Government on the destruction of wild beasts, I ascertained that during the four years 1901 to 1904 168 deaths of human beings were put down to the credit of this tigress alone, so that she killed on an average 42 persons a year. The figures for 1905 I could not get, as this district went over to Bengal on Partition Day, before the resolution for 1905 was published. The figures for kills in the Native State are also not available. The jungles where this tigress roamed were practically deserted, even for purposes of procuring firewood, and the people were content to burn dried cow-dung cakes rather than risk being captured by the beast, which would track people on the sound of a hatchet, and would approach so stealthily that her presence was not known till she captured her victim. If several people happened to be together, and one strayed a little apart, he would be singled out, while small parties keeping together were not safe, as the beast would sometimes appear and take off one or other. Her victims were always captured during the day, and at times within sight of the village. One Malguzar, or Gaoutia, as the head man of the village is called here, told me that he had rescued some persons as the beast was carrying them off, and none of them lived, as the four fangs were buried in the neck of the person, and all medical aid was futile. The beast had been at large so long, and all efforts to destroy her had been frustrated so often, that the people looked upon her as an incarnation of the deity, and native shikaris who were given licences to destroy this beast were afraid to make the attempt, as they said one or two shikaris had been killed in the attempt. When I shot the beast the people were wild with excitement, and village upon village turned out to see the beast, and I have since heard that the people brought out red paint to put on me, intending to worship me, so great was their dread of the beast and their veneration for the person who could destroy her.

"I have not heard of any man-eater prior to this one, but I heard that there was a family of man-eaters, this tigress, her mate, and two cubs. The tiger was said to have been killed some time early this year by a native, while a full-grown cub was destroyed about three weeks before I shot the tigress. But I cannot be certain that there was a family, and at any rate Government did not think so, as they offered a reward for one tigress alone, and all deaths were put down to her.

"She was so cunning that she never returned to a kill, whether a human being or a bullock specially tied out, and very frequently she would not touch a kill put out for her. I know this because it would sometimes happen that corpses would be found two or three days after the person was killed, only partly eaten, showing clearly that the beast ate her fill and went off, not to return. Again last February, and also in May, I sat up on moonlight nights over kills (bullocks) said to have been made by the man-eater, but she never appeared, though one night I heard her growl and pass by close to the kill. It was purely a piece of good luck that I got the beast. Hearing of a girl being killed on 14th September, just over the border in Sarangarh State, I hastened to the border and tied out kills. I must mention that latterly the tigress changed her tactics, and instead of clearing off after making a kill she would haunt the jungles around the spot for three or four days, and could be heard roaring.

"The second night I tied out kills she mauled a large buffalo, but did not kill him, and no doubt getting a scare of the buffalo she did not return. The following day she was seen by a wood-cutter near the

village tank before she saw him, and of course he ran to the villagers to give the news.

"That night I got no kill, but the following day she was heard roaring in the jungles around, and my kill (a bullock) was tied in the forest fire-line. She killed it, and as luck would have it she managed to break the string, and she dragged the kill away some 200 yards or more into heavy forest, and left it in a stream of water, practically covered by water. The kill was not touched, but my *machan* was put up some 50 yards away, and I got up at noon. At 2 p.m. the beast started roaring, and the sound came nearer, till finally (at 2.30 p.m.) she appeared opposite me, and as she was looking at her kill I put a ·303 bullet into her forehead, and she went down like a nine-pin. I am convinced that had she not dragged the kill away and hidden it she would not have returned to it. Officers in the Central Provinces frequently tried all sorts of devices to destroy the beast, but to no purpose. One device was to have a dummy dressed as a man or woman with bangles on under a tree, and to pull it by a string attached to the *machan*, but the beast could not be taken in. Once in a beat she is said to have come out charging, but was missed by the person who fired at her. This was the only time she was within gun-shot and visible. It only remains to add that since the destruction of this tigress human kills have ceased entirely, and the people freely enter the jungle since it is universally believed that the man-eater is dead."

In the article on "Zoology," contributed by the late Dr. W. T. Blanford to the new edition of *The Imperial Gazetteer of India*, it is pointed out "that owing to the steady destruction of tigers in India, the tale of human victims has diminished, and only 866 deaths caused by tigers were reported in 1904, whilst, forty years ago, 700 people were said to be killed yearly in Bengal alone." The figures for 1905-6 show a total of 786 for all India, the deaths being distributed as follows:—Bengal, 390; Madras, 155; Central Provinces, 105; Eastern Bengal and Assam, 75; Burma, 43; United Provinces, 14; Bombay 4. The number of persons killed by other wild animals during the twelve months appears to have been 1,268. The cattle destroyed by tigers alone in 1905-06 numbered 30,683. In the same period 16,915 wild animals and 63,719 snakes were destroyed.

Modes of Tiger Slaying.

And now as to the killing of tigers generally. This is accomplished in various ways—by netting, by shooting over water, or over a kill, by beating on foot or by means of elephants, and occasionally by poisoning with strychnia inserted into the kills left by tigers.

In 1902 I went to Mysore especially to see tigers netted. I spent some time there waiting until the Maharaja's shikari had got reliable information as to the tigers being surrounded with the nets in distant jungles, but wearied by delays and disapointment I left, alas! only to be informed that, two days later, three tigers had been netted and safely caged. I can, therefore, only give you second-hand information.

The nets are made of stout rope with a large mesh, and run up to 40 feet in length with a depth of 12 feet. When a tiger has killed a bullock the villagers, who have been warned to be in readiness, set up their nets crescent shape across the line which the tiger is likely to take when driven. Pieces of net are tied together, and the line will often extend a quarter of a mile or more, reaching into the country on either flank. The nets are placed behind a large patch of the thickest jungle, and when the tiger is driven up to the net he invariably lies up in this thicket, instead of breaking out with a charge. Men placed in trees signal the moment when the beast has reached the right spot, and immediately the two wings close in from behind, and complete the circle of nets, using spare lengths if necessary. Spearmen are placed at close intervals all round to repel the tiger should he meditate a charge, and the nets, strongly fastened to the ground with pegs and heavy logs of wood, are supported at a height of 9 or 10 feet by forked sticks stiffened with an interlacing of branches and thorns. A barrier is thus formed, and at night men with fires are posted round. If the tiger is to be caught alive a trap-door cage baited with a goat is introduced; hunger will compel the tiger to enter. If the tiger is to be shot, the circumference of the nets is contracted until less than an acre of jungle is enclosed. A party of some 20 picked spearmen then enter the enclosure, and form a ring round a like number of men armed with choppers, and a few others with horns and tom-toms. The duty of this party is to cut diagonal tracks 10 to 20 feet wide in order to render the tiger visible when moved. This task looks highly dangerous. It might be imagined that the tiger, maddened by rage, hunger, and thirst, would seize the chance for a charge, but a charge home has never been known. The tiger will not face a compact and noisy body of men while there is any way of retreat. When the cutting is finished, the rifles take their stand outside the nets on platforms which command the clear-

ings, and the beaters by shouting and using fireworks try to drive the tiger from one block to the other. The beast, when he moves, does so at a gallop, and is often missed, as it takes a quick shot to stop the animal when crossing a narrow opening. The spectacle of an angry tiger thus moving about is magnificent. Durthe night the tiger always moves round the enclosure, and makes many desperate charges, which are repelled by the spearmen on guard by their watch fires at close intervals.

In only one instance has a tiger been ever known to jump the nets. In this case at early morning he jumped the net 9 feet high, and fell on top of two watchmen, both of whom he considerably mauled, The Hon. Mr. S. M. Fraser, the Resident of Mysore, to whom I am indebted for my information about netting, was present on this occasion. Netting is chiefly carried on by the direction of the Maharaja on special occasions only, to catch tigers alive for his Highness's collection, to present to other Zoological Gardens, or to provide shooting for visitors.

If you go to the Zoological Gardens here in London you will see a tiger the gift of the Maharaja of Mysore, which, with a companion since dead, was netted a few years back. Alas, how different he is from what he once was! There is always a vast difference between the larger wild animals in their own native wilds and those we see in zoological collections, where they are almost unrecognisable by one who has seen them in their natural habitat. This can easily be understood. The wild beast in his native forest is a picture of strength and activity. His free life gives him a magnificent muscular development. But a caged existence, without exercise and without exertion to gain food, soon makes him a contemptible travesty of his former self. I frequently see pictures in art exhibitions of wild animals I have seen in their native wilds. These paintings may be great works of art, but they are not true to nature, and are I suppose taken from models in zoological collections. The tiger is often represented on canvas as moving about in the open. This he scarcely ever does. Watch a domestic cat moving about. If a wall or border of shrub is near he moves under the shadow of it. Even in a house he prefers to walk alongside the walls to walking direct across an open room. If a tiger or panther moves in the open his life is made unbearable. Every bird has a note of alarm which he uses to denote the presence of a foe. The sambar bells and the small bekri deer barks. The monkey goes wild with excitement, uses the most terrible language, shakes the branches of trees, and follows the tiger from tree to tree. Even the crow delights to follow and give the tiger a piece of his mind. The stately peacock also has a note of alarm, and in jungles where the tiger is about he flies, for he fears to walk.

As to the other methods of disposing of tigers to which I have referred, shooting over water and kills is poor sport. I have had no experience of beating up tigers in high jungles with a long line of elephants. Elephants for howdah shooting are not easily procured in Western India. I have, however, on several occasions had the use of them for the purpose of following up wounded beasts. It is a grand sight to see a wounded tiger charge towards one when safely esconced in a howdah on a staunch tusker elephant. Then one has all the excitement but none of the danger which one experiences when following him up on foot. The sportsman in the howdah is quite safe.

It may be of interest if I explain how the tiger is usually killed by the sportsman who has not the use of elephants. The practice is to take one's camp to a tiger country and then tie up young buffaloes in a number of places within ten miles of camp. The places selected for tying up are generally on paths near water, or in such places as the shikaris think most suitable. In the hot weather water gets scarce and wild animals concentrate in places where water is obtainable. The shikaris go out at daylight to inspect, and when they find a buffalo killed they take steps to find out where the tiger has gone to lie up during the heat of the day. If he has well gorged himself he first drinks and then makes for the nearest shady place to sleep off his debauch. By means of tracking a skilful shikari is able to make sure of the place where the tiger is lying up. Having traced him into a shady jungle he makes a circle round this, carefully looking to see if any pugs lead out of it. If he finds no such pugs he knows the tiger is asleep or resting within the circle. He then sends back to let his master know the tiger is located and arrangements are made for the beat. The sportsman has one or two good jungle men with him, chosen from the local wild tribes, generally Bhils.

The guns are placed upon trees, or on high ground or rocks which command the jungle. A tree is the best place, because the tiger never looks up a tree, but if the guns were placed on level ground the tiger would soon

see the sportsman, and turn back. The beat then commences, and the tiger is driven towards the gun. As soon as a shot is fired all the beaters are told to get up trees. An unwounded tiger is seldom dangerous, but when wounded he will attack the first man who comes near him; hence the necessity of always following up and killing a wounded beast. An old friend of mine, Mr. G. L. Gibson, had to leave a tiger after wounding him. Next day he went to the same jungle, and came on the body of a boy tending goats, who had been just killed by the tiger. Whilst Mr. Gibson was examining the boy the tiger sprang out and seized him, mauling him so badly that he died. To follow up a wounded tiger is no doubt dangerous, but if great care is exercised by people not subject to panic the danger is not so great as some might suppose. A tiger will not charge a compact body of men making a bold front. He may make a charge in the direction of his enemies, and emit the most heartrending growls, but he will not make his charge good if all stand firm. If anyone, however, runs off he will be at the mercy of the infuriated animal.

It is not easy to follow a trail in a compact body in thick and rocky jungle. Therefore, the compact body often move about in skirmishing order, which is dangerous, The guns should keep in front, with a mass of beaters behind. Sometimes when getting near, the tiger reveals his presence by roaring, but if he is badly wounded and in thick jungle he remains still. In such a case the usual practice is to send beaters up trees, and move closer and closer until the tiger can be seen from the top of a tree. If he can be seen from a tree one of the guns goes up and fires from the tree, If the tiger is only slightly wounded, following up is very tedious, as one has to move very slowly. I have spent a whole day in following up a beast. People get careless too after a time. Some tigers are arrant cowards, and show no fight. A tigress with her cubs is not always very fierce. I have had one charge me into the open, and then turn back after being fired at.

Other Wild Animals.

The panther (*Felis pardus*) is fairly numerous over most parts of India. He is often found in the plains, away from thick jungle, along nullahs, on the banks of rivers, and amongst treeless hills. He has, therefore, a much greater scope for roaming than the tiger. I do not think the panther is likely to become extinct for a long time. He breeds oftener than the tiger. His favourite food is the goat and village dog, but he will kill deer of all sorts, and bullocks, wild pig, monkeys, and in fact almost anything. He will even eat freshly killed carrion. I have had the trunk of a skinned bear taken off by panthers close to my camp at night. There are several sportsmen in India who have speared panthers from horseback. They are, however, usually shot and killed in much the same way as tigers. They are very active in their movements and can climb trees. I have known an instance of one climbing a tree and mauling a beater who was posted there. The male panther is quite as fierce and dangerous as the tiger. The panther too takes to man eating, and there have been many notorious man eaters which rendered some localities almost uninhabitable. I once was quite close to a wounded panther killing a man. The panther was making a low growl just like a cat when it has caught a mouse.

The Indian or sloth bear (*Melursus ursinus*) is still common all over India but is fast disappearing. In jungles where I used to shoot bears when I first went to India there are now scarcely any. This creature still has some strongholds in jungles containing rocky hills with caves, where he is difficult to find, but he will soon become extinct if he is not protected. He is more easily found by the sportsman than some other game. The favourite plan is to send out men over night, who will watch the hills and notice him returning from his feeding ground at dawn of day. His lair can then be marked down. If no caves are available he will lie up in thick bushes. The sportsman can then have him beaten out, or, what is more easy, wall him up and shoot him. After being first wakened, he takes some little time to realise his position, and whilst he is cogitating lead can be pumped into him. He is not easy to get out of a cave. I have seen fox terriers turn a bear out by incessant barking, but only for him to return with a fixed determination to keep inside till night time.

He also is dangerous when wounded, and will charge with great bravery. He occasionally bears enmity to human beings, and will kill human beings, although not with the intention of eating them. A friend and I once were so fortunate as to kill a man-killing bear just after he had mauled a victim close to his village in the hills.

He has one peculiarity. If he is shot and wounded whilst in the company of other bears he will turn on his companions and fight them. I once bagged three bears in as many minutes owing to my wounding the leading bear, who stopped to fight his companions. During the *mêlée* I fired until there was perfect peace. The bear can get over rough ground very rapidly. I have seen him form himself into a ball and roll down hill.

The Indian bison (*Bos gaurus*) is a splendid animal; the bull bison attaining to a great size—nearly 19 hands at the shoulder. This measurement, however, is much increased by a large dorsal ridge. He is found in all hilly forests, especially where bamboo jungles are plentiful. The large bulls generally separate from the herd and move about alone, but I have seen and shot two large bulls in company. He is generally shot by stalking. He is shy rather than fierce, and, even when wounded, seldom attacks a man. I have known instances, however, to the contrary. I saw one charge because his companion was shot, and, moreover, I had to get up an adjacent tree for shelter, the bison waiting for me below, until I dropped him with the fourth bullet. It remains to be seen if the Forest Rules will save him from extermination. He is not an animal who can be domesticated, though there are one or two instances where young calves have been. A few years ago I saw two three-year old cow bisons which had been kept in the Mysore gardens since they were captured as calves. They were allowed to roam about a garden and did not appear shy, but they were occasionally bad tempered. I saw one of these in January last; the other had died.

The sambar is found all over India but has decreased in numbers I fear, and is becoming comparatively rare in the Bombay Presidency. His hide has a good value for the native shikari. The stag has a magnificent head which makes an excellent trophy. In the cold weather excellent sport can be had in the Central Provinces by stalking—the only sportsmanlike way of killing him. He can be killed by beating him out of thick jungle, but this is not considered fair or proper sport. Sambar do not attain any great size in captivity. Some years ago I saw a large herd of sambar bred in Australia from a few which had been imported from India by the late Sir Samuel Wilson. They were kept in a large wired-in hilly tract covered with forest. None had heads of any size, nor did they appear to be so large as their Indian brethren.

The cheetul or spotted deer (*Cervus axis*) is another animal which gives good sport in stalking. The stag has a very good head much prized by sportsmen. He is found in much the same jungles as those frequented by the sambar, but has decreased very rapidly. Many years ago in the hot weather I saw a herd of 200 of them in the State of Hyderabad. They were very common there. This was 200 miles from a railway, but since then railways have been brought nearer and I fear the cheetul have suffered.

The blue bull is fairly common. The male has but small horns and few persons trouble to go after them.

The barasingha or swamp deer (*Cervus duvauceli*) appears to be increasing in the Central Provinces. He is now extinct in Sind.

The black buck and the chinkara are still fairly common everywhere in the plains and cultivated parts of India. The chinkara are found in nullahs and rough ground. They give excellent sport in stalking.

The bekri or four-horned antelope is fairly common.

The muntjac or barking-deer (*Cervulus muntjac*) is rare.

In the Bombay Presidency I have often shot the mouse deer (*Tragulus meminna*). He is about the smallest deer in the world, about 10 inches high at the shoulder. He is found in rocky jungle.

The wolf (*Canis lupus*) is found all over India. He does much mischief, and his extinction would not be regretted. There have been some noted wolf children-eaters in the Central Provinces, for whose deaths Government have offered large rewards.

The hyena is common everywhere. He, too, has taken to carry off children. There was one, many years ago, which captured a large number of children in the neighbourhood of Ahmedabad, and was killed with much difficulty.

The wild dog (*Cuon rutilans*) is found all over India. He is a great pest, and causes great destruction among the deer tribe. It is said that a pack of them will even attack the tiger, and sambar are frequently victims. I have two or three times come on packs hunting. The wild dog is a most shy and retiring animal, not much larger than an English fox. Great difficulty is experienced in keeping him in captivity. He seldom

lives long, and appears very miserable and dejected.

Preservation of Big Game.

This completes the list of the more important animals, and I now proceed to deal with a topic of national interest—the means adopted for preserving the big game of India from the extinction with which it is threatened. The Indian Government pays monetary rewards for the destruction of tigers and panthers—in some places I believe also for bears. I think the time has now come when these rewards should cease, except for noted man-eaters. It has always been the custom of Government to pay large special rewards for the killing of man-eaters. Government have of late years, I am glad to say, protected wild animals in State forests by issuing rules under the Indian Forest Act restricting shooting except on certain conditions, and they have also made certain forest sanctuaries for wild beasts where no shooting whatever is allowed. Big game is found mostly in Government forests, so that its protection by rules under the Forest Act may be effective if the rules can be enforced, and are sufficiently complete.

Some twenty years ago the Government of Bombay introduced a Bill for the protection of game, which was violently opposed by a Hindu member of the Legislative Council belonging to a caste whose rules forbid the taking of life. I forget what the objections were, but they induced Government to drop the proposed legislation. Later the Central Provinces Government passed forest rules for the protection of game. These rules were in effect almost prohibitive of all shooting, except for forest officers and gentlemen of unlimited means. These restrictions caused such an outcry that they had to be dropped. The Indian public seemed to be adverse to all rules for shooting or entering Government forests, for fear that such rules would be all in the interests of the officials living in the district. However, in 1902 the Central Provinces Government passed new forest rules, which appear to be fair and seem to have met with general approval.

The Central Provinces I think contain the best big game jungles in India, and it was felt that protection was required for big game other than carnivora. The carnivora are not protected under these rules, except that persons desirous of shooting in Government reserved forests have to get permits, for which they pay nothing, but they have to employ a forest guard to accompany them, so that indirectly a sportsman who shoots in a reserved forest (and such reserved forests are the ones in which most of the carnivora live) has to pay for his sport. In East Africa the Government charge strangers a very large fee for shooting big game. The Central Provinces rules provide for permits, which are limited to certain defined areas, but wounded game may be followed to an adjoining block. No person is allowed to sit up over water for the purpose of shooting any other animal than carnivora. Does, hinds, and fawns, and even immature stags are not to be shot, nor are the cows and calves of bison. There is a close season for stags between 1st June and 31st October. The killing of stags in velvet is also prohibited. Besides this, the various officers have power to limit the number of stags to be shot, and in some forests they forbid any shooting, in order to allow the game to get up. These rules have not been in force long enough to enable one to form a decided opinion as to the effect, but they should at any rate preserve other than carnivora.

The Bombay Government also have passed rules for the protection of game in forest reserves. These differ somewhat from those in force in the Central Provinces. The same charge (Rs.25 per annum) is made for both the northern parts of the Presidency and southern. The southern part contains the Canara jungles, and game is more plentiful there than in the northern circle, where great complaints are made of the fee. Forest and district officials are not exempt, and I have a complaint from a Government official to the effect that "outsiders" evade payment in every possible way. Young subalterns who may go out on the chance of shooting a panther do not like paying Rs.25 for the privilege, and forest officers who are doing their best to protect the game grumble at having to pay the same for the chance of a shot now and then. Complaints have also been made that the Bombay Government do not utilise the money they receive for shooting licences in the payment of rewards to informers whose testimony would secure the conviction of offenders, or in maintaining a special staff of watchers. The forest officers have enough to do as it is, without collecting evidence against those who break the rules.

The Bombay rules have only been in force for about a year, and it is impossible to say

what will be their ultimate effect. I first went to India thirty years ago, and I commenced my big game shooting at once. It was then possible to get fair bags of big game, consisting of tigers, panthers, bear, bison, sambar, and cheetul all over the Presidency. The Thana jungles, commencing within 20 miles of Bombay city, every year yielded many tigers, panthers, and bears to the sportsmen, but now, alas, few are left, although it is right to mention that a tiger was killed last year near Thana. I myself have shot tigers in the Thana jungles in the past, and I have seen many marks of tigers there. There are but a few left now.

In the Bombay Presidency big game is now so scarce as to come dangerously near to the vanishing point. I have consulted district officers as to the causes of the scarcity, and I trust that the record of my inquiries may lead to the adoption by Government of measures that will effectually check the evil.

Mr. Gleadow, Conservator of Forests of the Northern Circle of Bombay, perhaps the most competent witness that could be procured, has written me an important letter, dated Dec. 9, 1906, from which I make the following extracts :—

"The new rules have only been in force for a year, consequently it is quite impossible for the keenest observer to trace any effect at all. I may say that, compared to the supposed number of sportsmen, those who have thought it worth while to take out a licence form an insignificant minority. District officers have taken out licences to some extent, but as for private sportsmen, I suppose a dozen licences would cover the lot, so far as this circle is concerned.

"Although no effect can be traced by observation, it is not difficult to arrive at some conclusions. There are no great European nimrods in these days in this circle, so far as slaughter of game is concerned. There are first-class sportsmen a few, but nobody that I know of kills any quantity of game. Partly, the game takes too much finding: partly, official life is much too fully occupied now a days to leave much time for shikar.

"The European thus, in my opinion, counts for little in the world of wild animals. In the matter of blackbuck, one still occasionally hears of someone killing half a dozen or more a day for a week, but such cases are very few, and so are the tracts of country where it can be done. In my circle buck are considerably scarcer than they were 20 years ago, and that is all I can say on that point. Chital and sambhar? bless me, when did I see one last? These animals I know still exist, for I see an occasional pug, and a chital was shot last season by a railway man from above Ghats, near Tansa, but said to have been killed outside forest.

"No bison have been shot for several years that I know of, but one was killed by a tiger last year, apparently a good young bull, for Mr. Gilbert, of our service, found the skull, and the horns are very decent. The herd at present, I believe, comprises about a dozen, but, as you are aware, is liable to sudden diminution every few years, when foot and mouth disease or distemper gets in. The small deer, rib-faced, four-horned, and mouse, are still prevalent in most places, but can scarcely be called common now anywhere.

"Pig and nilgai are the brutes that want shooting, for they are too numerous in some parts, and a nuisance to the cultivators. The pig are not much shot because they are too wily, invariably breaking back through the line or lying low. They will come round camp as bold as brass on pitch dark nights, frightening horses and servants, but it is a rare pleasure to get a bullet into them.

"The nilgai are very common in parts because nobody shoots them. Hindus regard them as a species of cow (*gai*), and so more or less sacred, though I never heard of any trouble through shooting them.

"Panthers are still common, but not, therefore, easy to get. The famine years made many man-eaters. In the Dangs, in the impossibility of shooting them, they were all successfully trapped, perhaps a dozen of them. One is unaccounted for, and we hope dead. Tigers, I fancy, are slightly increasing; they were very scarce in this circle a few years back. They are very hard to trace now, but I fancy there are one or two more.

"Bears are certainly scarcer. Places I knew as haunts twenty years ago are drawn blank now. On the whole, everything is scarcer, including, I think, even pig.

"The reason is not the European sportsman, but the native who pays no licence. For one *bekri* killed by a sahib there must be a hundred killed by natives, and where a sahib will pass a whole year without killing chital or sambar, natives will kill a score. Sambar skins are brought for sale in some of the back districts by wild tribes, as are occasional skins of chital, bear, panther, &c. The wild tribes kill a good deal of game with guns of the rusty gas-pipe order, bows and arrows, and nets. They net not only birds and hares, but *bekri* too. The famine killed off a lot of game. Water was so scarce that the natives, and the felidae, too, knew (and sat over) every spring that had a drop in it, and sometimes there would not be another drop in the forest for twenty miles or more. Many animals must have died of thirst, as man did of hunger, after wandering through the forest till delirium overtook them. Panthers started on corpses and passed on to living subjects, but must have had a very poor time, nevertheless. I still find occasionally a few sticks, the remains of a rough shelter put up in some out-of-the-way forest recess by some unfortunate, who had abandoned his home on the chance of being able to

dig up enough roots to keep himself alive. The scarcity of water has continued since the famine of 1900 to the present time, last hot weather being the absolute lowest record in wells and springs. Last rains have been good, and I hope we have turned the corner, but there has been so much deforestment, both on State lands and private, especially the sub-ghaut region, where all the sources lie, that the water supply can never again be what it was, and that is saying very little, for it was never plentiful.

"You will, therefore, understand that I look upon the effect of the licence as negligible at present, in the face of the difficulty of controlling these irresponsible good friends of ours, the 'wild tribes,' and the poaching villager of more civilised parts. But the rule enabling me to create sanctuaries I value, and have totally forbidden the pursuit of bison. On the other hand, it is only fair that those who enjoy sporting over the State demesnes should pay something for the privilege, because if the old free system continued there would be a speedy end to all game. When there is not enough to go round some process of selection must be adopted and the test payment is practically the only one admissible in the present conditions of society.

"There is a grumble at the end, 'Thou shalt not muzzle the ox that treadeth out the corn.' The forester has to pay for his licence like anybody else, and the justification for this galling piece of disfavour is, that if he went free, the collector (who is a forest officer too, in name) and the assistant collector (who is ditto), and the whole hierarchy who have more or less status to interfere in forest affairs, would be jealous."

I have omitted from Mr. Gleadow's letter some portions relating to the troubles which forest officers have experienced in enforcing the payment of shooting fees by Europeans, and to the manner in which the former have, while exercising their official duties, been treated by certain sportsmen.

Mr. H. Murray, Conservator of Forests, Southern Circle, has also given me a great deal of information. He laments the decrease of game, and the difficulty of enforcing the forest rules to protect them. He complains of the great increase of wild pigs, and tells me that a herd of wild elephants have come into a part of his district in the Canara jungles, after an interval of nearly forty years. In my younger days, the Canara jungles were some of the best tiger and bison jungles in India, and many parties shot there every year, but now there are few bison and tiger left. It is quite common for parties now to go out, and not get a shot at big game. In former days, there were bison near the Hill Stations of Lanowlee and Mahableshwar. In the cemetery at Mahableshwar is the grave of an officer stated to have been killed by a bull bison, but there has not been a bison in these places for many years. In fact, there are none left in the whole Presidency of Bombay, except a small herd in the Thana jungles, and also some in the Canara and Khandeish jungles. The bison in the Thana jungles were, to me, a great object of interest for many years. I have frequently seen them, and had them pass close to me. I understand that they now number about twelve. The forest in which they are mostly found is within 35 miles of Bombay city, and it is now a sanctuary; let us hope that they will increase and multiply. The district officers have for twenty years past been doing their utmost to preserve them, and the Bombay Natural History Society has used all its influence to help. It has long been considered very bad form to shoot them. They, however, have not increased much, and this has been attributed to the devastation of cattle plague. Whenever cattle plague has appeared in the district the bison have invariably been attacked and suffered from it. The jungles in which they live are ideal jungles for bison—plenty of bamboo and water with timbered hills. The Thana reserve forests are very large, and they have plenty of room there to wander in solitude. Bison appear unable to exist near human habitation; are not nearly so common in the Satpuras in the Central Provinces as they used to be, and I fear they will be the first to disappear altogether.

The Central Provinces and Central India are more favoured than the Western Presidency. Complaints of the decrease of big game are not so great there as in Bombay. Indeed I have received evidence of the increase of bison, sambar, and swamp deer in some parts. Central India, as you know, is largely composed of Native States, and the chiefs and rajas of that territory now look on their big game as a valuable asset. Many of them are keen sportsmen, and are anxious to preserve their game for themselves and their guests. So many great men now come to India who are desirous of killing a tiger, and the rajas are very hospitable to this class of visitor, keeping special preserves in which tigers can always be shot. I think, therefore, that the Indian princes and chiefs will do their utmost to protect big game in their States.

I was in Sind last winter, and I made special inquiries there. When I first went to India the tiger was often met with in Sind along the banks of the Indus, but not a single one is to be found there now. The last was killed

about twenty years ago. The barasingha, or swamp deer, was also fairly common in Sind, but he has become extinct. The hog deer and the chinkara are there still, but the natives, I hear, wage a continuous war on them, and in a few years, I believe, they also will vanish. The ibex, however, still flourishes in the hills north of Sind.

The forest rules of the United Provinces of Agra and Oudh, lately promulgated, have been adversely criticised in the Indian press. It is said that the district officials are favoured to the disadvantage of other sportsmen. One complaint is that sportsmen using elephants have to pay fees which are prohibitive except to millionaires. But persons who can afford to shoot with elephants can afford to pay high fees. The annual fee to shoot is 100 rupees, but reduced amounts are charged for short periods in small forest areas. It is objected, however, that the rules can be worked so that outsiders get little or no shooting with these minor licences. I have had no experience of shooting in these districts, so I do not myself criticise these particular rules.

Mr. A. A. Dunbar Brander, Deputy Conservator of Forests in the Central Provinces, who takes a great interest in big game, and has made a special study of the subject, has been good enough to give me much information. His view is that the only persons who do harm to big game are the native shikaris, who shoot for their living, and the natives who get licences to use arms for the protection of their crops, but who use their licences for the indiscriminate slaughter of game. The amount of mischief these people do is enormous. His point is that the harm they do is from March to July, in the hot weather, shooting over water; and that in order to stop this, licences should not be issued, under the Arms Act, to this class of people during those months, especially as, in this period, crops do not require to be protected from game. He has, I believe, urged his views upon his Government, and it is hoped that Government may restrict the issue of gun licences for this period of the year. His proposal, in my opinion, is the best, and indeed the only way of completing the good work carried on under the forest rules, and it would be a means of effectually protecting big game. As regards various animals, Mr. Brander writes:—

"Bison are hardly ever shot by natives. Only Europeans and tigers kill them. They have decidedly increased, and are now common in some parts, where in Mutiny and pre-Mutiny times there were none. Nature sets a limit, and a low one, on the numbers to which such big animals may reach, and every now and again rinderpest, foot-and-mouth disease, reduce a number of herds to a few individuals. I counted 80 dead in one year in one forest block. But the bison's future is assured, and as our forests get denser so they will be spread further."

Mr. Brander further tells me that buffaloes are only found in a few places in the Central Provinces: they are holding their own. Sambar are increasing, and more numerous than they were ten and twenty years ago, due to a strict protection and destruction of outlying forests. Tigers are getting rapidly scarcer, due to restricted area and European sportsmen. Panthers are as common as ever. "Bears" he adds, "are getting rapidly scarcer; I am unable to assign a cause to this undoubted fact. Few are shot comparatively. Wild dogs have increased much of late; I can assign no reason for this, and have heard none. They do an immense amount of damage. Cheetah, I am unable to say definitely, but I am inclined to think they are getting scarcer; I am inclined to think they will want careful handling, as they will get scarce in the next 30 years. Many of our forests are now too thick to hold them, and when this happens they will disappear."

DISCUSSION.

The CHAIRMAN (Sir William Lee-Warner) said that on his entering the room some one expressed to him the doubt whether the subject of discussion was quite worthy of the august Society. If any one entertained similar doubts, he would ask him to remember that the protection of the fauna of our Empire was a responsibility to mankind, which, if neglected, meant an irreparable loss. An important association existed in London, which watched over the same interest in Africa, and it was the duty of those responsible for Indian administration to give it a thought. Again, there were large aboriginal races in India who lived side by side with the beasts of the forests, and no one could enter into their hearts and lives, who did not enter their forests, such were Outram, Probyn, Propert, and others, who knew and ruled the Bhils, and it was to be hoped that other public servants would follow their example. Lastly, we ruled India by the possession of many qualities, a sense of justice and sympathy, and also a nerve, resourcefulness and courage, which were developed by sport. The author of the paper, to whom the thanks of the Society were due, had touched upon many points, and he (the Chairman) could only select a few of them. He had referred to the almost entire disappearance of the lion, and seemed to re-

gard the limits of its existence as formerly confined to Central India. His (the Chairman's) modest course of reading inclined him to believe that the lion was once widely distributed over most parts of India, and gave a warning to mankind in that the disappearance of this species was as much due to its own defects of character as to the overlordship of man, against which the tiger also had to contend. As to the evidences of the lion's wide *habitat*, the famous Sir Thomas Roe relates that on the 11th of March (1616 ?), when he hoped to open business with the King, the news of a lion, which had killed the royal horses, took His Majesty off to hunt near Mandu. The occurrence is referred to as if it were quite ordinary. Fifty years later Dr. John Fryer sums up his observation, made in 1673: "Lions here are some, but feeble and cowardly." Bishop Heber, in 1823, mentions their existence in Seharanpur, Ludiana, and Moradabad. The reports collected on the subject of slavery in India frequently refer to famine-stricken natives falling preys to lions, as well as being sold into slavery. One writer argues indeed that lions were not found in Southern India, but only on the ground which is hardly conclusive that the sculptures on rock and temple in the South pourtray such impossible lions that the artist evidently had no model. But this would banish the horse from Persia, where pictures and carvings frequently represent a most abnormal creature. The evidence generally points to a wide diffusion of the lion in India, which, however, seems to have returned the ass's compliment and borrowed its nature of "feebleness and cowardice," so as to fall an easy prey to its destroyers. Mr. Gilbert's correction of the popular error about man-eating tigers is borne out by older authorities. Major Henry Shakespeare's "Wild Sports of India," published by Smith Elder in 1862, mentions of a man-eater killed by him at Donghargarh, that "thirteen quarts of fat were taken from the lusty animal." The famous "three-fanged tigress of Bogarum," which between 1847-49 took off 133 human victims, must have been equally lusty. Mr. Gilbert had not mentioned whether the tiger of the present day had the same tastes as its predecessor. It used to be the practice of man-eaters, to begin with the foot and leg of a human kill, while the hindquarters of a bullock were the first parts eaten. Every one who had followed the chase in Indian jungles, knew how it developed sympathy. In the speaker's case it had developed trust and dependence. On one occasion, while after bison, he was enveloped by a forest fire, and, after a while, felt perfectly helpless. He owed his life entirely to a half-civilised hillman. The grave question of forest preserves and shooting licences was too large a subject to discuss at present. On the one hand, it seemed right that wild beasts of all sorts should be allowed a sanctuary; while, on the other, the special claims of forest and district officers, and the still more special claims of villagers and landowners to protection of life and property, should be recognised.

Dr. TOM G. LONGSTAFF inquired whether the author was of opinion that there were two species of panther in India or only one. Some sportsmen considered there were two, while many others thought there was only one.

Mr. GILBERT stated that only a short time ago he had a conversation on that very subject in Bombay with Father Dreckman, S.J., who was one of the best Indian naturalists with whom he was acquainted, and it was that gentleman's opinion that there was only one kind of panther in India. Personally he was only acquainted with one part of India, and certainly in that part there was only one kind of panther.

Mr. W. S. LOCKHART, M.Inst.C.E., inquired whether the author knew how a leopard moved its kill—whether he dragged it or got under it. He had known a leopard measuring 7 ft. 3 in. in length kill a big pony and drag it several hundred yards, all up hill and partly through thick scrub. The pony belonged to a detachment of Goorkha Mounted Infantry, and the Goorkhas were not long in finding the kill and the next night the leopard got shot. A leopard, although a most powerful beast, is after all only a small one as compared with a pony and yet this one was able to move a big pony a considerable distance. If the author could throw any light on the subject he thought it would be of interest to sportsmen.

Lieut.-Colonel G. W. MACAULEY stated that, with the permission of the Chairman, he would reply to Mr. Lockhart's question as he happened to have seen a kill. The tiger crept along, seized the bullock by the throat, pulled it down and sucked its blood. It then went away, came back in about a quarter of an hour, seized the animal by the throat, and, putting one of its forepaws on each side of the bullock, dragged it backwards into a thick cover, where he sat down and eat a portion of it, beginning with the flank. The tiger never attempted to lift the bullock in that case.

Rear-Admiral R. A. J. MONTGOMERIE, C.V.O., C.B., C.M.G., in dealing with the question of the dragging of carcases after they had been killed by wild beasts, said it was a well-known thing that a lion would kill a donkey and jump over a boma with it. He had shot a great many wild animals, and had seen a leopard in the daytime take a hartebeeste, weighing about 200 lbs., put his head underneath it so that the carcase was hanging over his neck, and carry it away. He had had a good deal of experience in studying the tracks of beasts in the morning, and had never seen marks corresponding with a tiger dragging its kill along backwards as described by the previous speaker.

a place where cattle were penned at night. It was about 4½ to 5 feet high, constructed of railway sleepers, and it was only possible to get into it by pushing or driving the animals in. It was purposely devised for the herding of cattle in that part of the jungle at night. They were told when they were being shown over the place, that a buffalo had been taken from its stall by a big tiger, which had jumped on to the top of it, as a cat would a mouse, and carried it away. The man who told them the story, informed them that the tiger had slung the buffalo over his back. He was perfectly certain the buffalo could not have been dragged out of the enclosure, but it must, he presumed, have been carried. The tiger was eventually killed. He desired to ask the author whether he thought that mode of removal possible. He also desired to ask whether, in the author's experience, a man-eater always ate the leg of a human being first, whilst it began on the hind-quarters of a bullock.

Mr. Gilbert, in reply to the Chairman's question, said he had heard it stated that man-eaters commenced on the leg of a human being first, but he could only speak from hearsay. It was well-known that they always eat the rumpsteak of an ox first. He also had no reliable information on the subject of a tiger carrying off the kill in its mouth. In reply to Mr. Lockhart, it was well-known that leopards could draw enormous carcases about, while the audience would remember that in the case of one of the tigers he mentioned in the paper it pulled a big sambar, which it had killed, for some distance and swam with it across a river. The tigers dragged their kill along somehow.

Mr. Alexander Rogers remarked that he rose, not to boast of any of his shooting exploits, for he had not shot many wild beasts, but to ask whether it it was now becoming the fashion for sportsmen to use guns or rifles which fired both barrels with one trigger. Formerly he was in the habit of using a Rigby rifle which fired both barrels with one trigger, and he wished to utter a word of warning to gentlemen who used weapons of that kind, to be perfectly cool and collected, and to notice what they were doing. If a gun or rifle which fired both barrels with one trigger was used it was essential that it should be a self-acting one. He would illustrate that point by mentioning one of his own experiences. He had shot at a panther in a bush with a Rigby rifle, and according to the usual custom had put both hammers on full cock and fired. The right barrel went off first and bowled over the panther in the bush. In the flurry of the moment, as he stood to receive the panther's charge he thought that he could kill it with the left barrel, and forgetting its peculiar trick pulled up the right hammer again. On looking at his gun he found he had mistaken its action and that the left barrel was still loaded. He pulled the right hammer action and of course it went down on the empty cap. He was thereby exposed to the charge of the creature and naturally turned round to get out of its way. At the same moment he saw that the panther had fallen, and looking at his gun again, and finding that the left barrel was all right, took another shot and killed him. He only brought that instance forward as a warning to sportsmen who used guns which fired both barrels with a single trigger, to take care what they were doing, and to have a gun which, after the right barrel was fired, brought the left barrel into play by automatic action.

The Chairman remembered in 1869, when at the Ghauts, near Lanowlee, with Jim Oliphant, seeing

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Gilbert for his interesting paper.

Mr. Gilbert, in acknowledging the compliment, thanked Sir William Lee-Warner for his kindness in the chair and for the remarks he had made, and also thanked the audience for the very kind way in which they had received his paper.

Dr. Tom G. Longstaff writes:—I much enjoyed Mr. Gilbert's paper, but I regret extremely that I did not know beforehand that he was going to touch game preservation in India. It was too late for me to go into that. The point is that it is not the sportsman who is the greatest enemy to the game. The native at the drinking places in the hot weather, and the *red dog*, do more harm than the resident sportsmen. Again, the greatest damage to crops is done by the pig, the black buck, and the nilgai. The nilgai is worst of all and is never touched by the Hindu, and it is in Hindu India that it lives with only a very few exceptions. Hissar is eaten up by vast herds of black buck, which are rarely touched by the native. The Bhil and the Gond take their toll of the deer, but most of the damage is done by the local shikari. He hunts also for trophies, which are sold to dealers. They again sell to the globe trotter. Prohibit the *sale* of trophies in India and you stop the slaughter.

Colonel C. E. Yate, C.S.I., C.M.G., late Chief Commissioner of Baluchistan, writes:—Referring to Mr. Gilbert's remarks on the preservation of big game in India, I think with him that the time has now come when rewards for the killing of tigers, panthers, and bears, etc., may well cease, and that these rewards in future should be limited to man-eaters. To protect wild animals by forest rules on the one hand and to offer rewards for killing them

on the other is anomalous to say the least of it. The great thing before us is to put a stop to the indiscriminate slaughter of game by the poaching methods of the native shikari. The European sportsman, as Mr. Gleadow says, "counts for little in the world of wild animals." I think that with reference to Europeans the example set by East Africa may well be followed, and there, as Mr. Gilbert told us, "the Government charge *strangers* a very large fee for shooting big game." Parties who come out to India for big game shooting may well be charged large fees, but Europeans and Indians in Government service in India, and who are residing in India, should, I think, be only charged a small nominal fee, just sufficient to form a fund for the maintenance of a staff of watchers and for rewards to those bringing about the conviction of offenders. The first, a principal thing, I take it, is to secure a limitation to the issue of licences to use arms for the so-called protection of crops. These licence holders are the men who do the main mischief. No licence should be issued except in cases where, after due inquiry, real damage to crops can be shown, and, when issued, the licences should apply only for the period of the year that particular kind of crop is on the ground, and never in any circumstances for the $4\frac{1}{2}$ hot weather months, from 1st March to 15th July, when, as Mr. Brander says, "crops do not require to be protected from game," as, in fact, there are no crops to protect. Licences also should lapse at the end of the period stated, and only be renewable, year by year, on necessity being proved; a small registration fee might also be levied on each licence. It is not only the does, hinds, and fawns of our deer that have to be protected, but it is the extinction of such grand game birds as the black partridge, and other birds of that sort, that has also to be prevented. The murder of game birds in the breeding season, by native shikaris, is largely responsible for the present scarcity of small game, and all efforts should, I think, be directed to the prevention of that. It is said that it is no good passing game laws, when they cannot be enforced, but that, I take it, is not the right way to look at the matter. Let the Bill for the protection of game be passed, and let it be a penal offence to kill game within the close time fixed in each province, according to its needs, and then, at any rate, local officers will have firm ground to work upon. They will assuredly enforce those laws to the best of their ability, and as time goes on their powers in this respect will increase and not diminish. It was in spirit that I issued game rules in Baluchistan and what can be done in a wild frontier province like Baluchistan can be also done in the more settled provinces of India proper. Game laws are only recognised for British provinces. Native chiefs can well be trusted to preserve the game in their own States themselves. All who are interested in the preservation of game in India are much indebted to Mr. Gilbert for bringing the subject forward in the way he has done.

FIFTH ORDINARY MEETING.

Wednesday, December 18th, 1907; Major-General Sir OWEN TUDOR-BURNE, G.C.I.E., K.C.S.I., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Brierley, Harry H., 8, Oaklands-road, East Sheen, S.W.
Christy, Cuthbert, M.B., C.M. (Edin.), care of Messrs. Smith, Mackenzie and Co., Mombasa, British East Africa, and Royal Societies Club, St. James-street, S.W.
Coats, Matthew, F.C.I.S., 82, Ham-park-road, Forest-gate, E.
Gilbert, Reginald, F.Z.S., Llanelwedd-hall, Built Wells, Breconshire, North Wales.
Reid, Alexander Scott, Assoc.Inst.M.M., care of The Waihi Gold Mining Company, Limited, 11, Abchurch-lane, E.C.
Tarapore, P. C., F.R.G.S., Sutherland-house, 2, Greencroft-gardens, N.W.

The following candidates were balloted for and duly elected members of the Society:—

Archibald, Andrew Manley, F.R.G.S., 7, Terrapin-road, Balham, S.W.
Bailward, Colonel A. C., 1, Princes-mansions, Victoria-street, S.W.
Brannam, Charles H., Litchdon-street, Barnstaple, Devonshire.
Elder, Arthur S. W., Assoc.M.Inst.C.E., Newbold, Edenbridge, Kent.
Foster, Harold Duncan, 20, Norfolk-road, Regent's park, N.W.
Graham, John Campbell, M.A., M.D., 69, Kensington-gardens-square, W., and Bindjey, Deli, Sumatra, Netherlands India.
Gray, Herbert Charles, A.M.I.E.E., Telephone-house, Victoria-embankment, E.C.
Henri, Arthur, 6, Hopton-road, Streatham, S.W.
Morrow, Robert Alexander, 6, Landridge-road, Fulham-park, S.W.
Taylor, Miss Laura E., 64, Emanuel-road, Balham, S.W.
Vallat, Henry Howard, 26, Stonor-road, West Kensington, W.
Wilson, Joseph, Messrs. W. Crowder and Co., Limited, Bombay, India.

The CHAIRMAN (Sir Owen Tudor Burne) said—It is my duty and pleasure, as Chairman of this meeting, to introduce to you M. Lucien Hubert, who has kindly come over from France to address us on the interesting subject of which you have all had notice. M. Hubert bears, as many of you may know, a distinguished name and reputation in the French Chamber of Deputies, and is Vice-President of the

Committee on Exterior Affairs in that chamber. If I may be permitted to say so in his presence, he is much relied on in his own country as an exceptional authority on matters affecting the French colonies and dependencies; and during his eminent career has gained for himself that public regard and confidence which will, no doubt, lead him to fulfil even higher positions in the political service of his country than the important posts he now holds.

The paper read was—

LE RÔLE DE LA FRANCE EN AFRIQUE OCCIDENTALE.

Par Monsieur Lucien Hubert,
Député des Ardennes.

S'il est un sujet qu'un conférencier français doive redouter de traiter devant un auditoire anglais, c'est bien celui des méthodes de colonisation.

Que pourrais-je dire sur cette question que vous n'ayez depuis longtemps conçu, expérimenté, éprouvé? Oublierais-je que l'Angleterre n'est pas seulement la première puissance coloniale par le nombre, l'étendue et la prospérité de ses possessions, mais encore que son effort réfléchi et volontaire d'expansion dans les temps modernes a devancé le nôtre de plus d'un siècle, et qu'elle y a apporté toutes les qualités de son génie national, l'obstination que rien ne rebute, la souplesse et l'ampleur d'esprit qui permettent d'envisager simultanément toutes les solutions d'un même problème, enfin cette soudaineté d'initiative qui abrège la discussion pour courir tout de suite à l'épreuve décisive des faits?

Non, mesdames et messieurs, je ne puis même un instant méconnaître la contribution magnifique que dans cet ordre d'idées votre nation a apportée à l'expérience générale de l'humanité civilisée. Et si j'allais jusqu'au bout de ma pensée, je dirais que ce phénomène moderne de la colonisation, cette entreprise raisonnée d'organisation mondiale, en tant qu'elle est sans précédent dans l'histoire et qu'elle constitue une véritable nouveauté propre à nos sociétés modernes, est une conception essentiellement anglaise. S'il est vrai que chaque grand peuple s'est distingué par une puissance de création personnelle dans tel ou tel domaine de l'activité humaine, s'il est vrai, par exemple, que les arts plastiques aient eu leur vraie patrie en Grèce et les sciences juridiques à Rome, l'on devra dire que la colonisation est avant tout une invention anglaise. C'est en cette manifestation que s'est incarnée de tout temps votre activité politique. Et si vous avez aujourd'hui des imitateurs, osons même dire des rivaux, vous demeurez les initiateurs, les chefs d'école, les maîtres dont la tradition fait autorité.

Tout cela, mesdames et messieurs, je me le suis dit avant de venir ici; et ces considérations ne m'ont pas fait hésiter. J'ai la conviction que l'œuvre de ma patrie vaut d'être exposée à des connaisseurs tels que vous. J'ai même la certitude qu'elle trouvera en vous des juges d'autant plus bienveillants qu'ils sont plus éclairés.

La France s'est remise un peu hâtivement, parce que tardivement, à l'œuvre de la colonisation. Au lendemain de ses malheurs, un instinct fiévreux faisait obscurément comprendre à ses dirigeants que le sort définitif des nations ne se jouerait bientôt plus sur la scène européenne, mais sur un théâtre plus large, où vous nous aviez précédés.

Cette nouvelle orientation de notre politique fut décidée précipitamment. La grande masse de la nation n'en voyait que peu de chose, et pour lui faire accepter cette déviation de ses rêves et de ses espérances, il fallut toute la séduction de la lointaine épopée qui parait d'un peu de gloire son drapeau relevé.

Le premier soin devait être de constituer avec une hâte nécessaire notre domaine. Nous avons, je la sais, encouru parfois vos railleries, dans notre empressement à occuper les rares places que votre débordante et ancienne activité nous laissait encore vacantes. Il semblait même qu'il y eût quelque chose de puéril à devancer ainsi par notre action politique des besoins économiques qui ne s'étaient pas encore affirmés. Et pourtant cette méthode seule était sage. Devant l'univers largement offert, vous aviez pu dès l'avant-dernier siècle, aisément dégagés de la concurrence timide et inconsciente que nous vous opposions à peine, vous aviez pu prendre votre temps, choisir votre terrain, et laisser naturellement grandir et fructifier les semences de prospérité hardiment jetées un peu partout: vous pouviez à loisir sélectionner vos colonies. Les nôtres, au contraire, devaient nécessairement ressembler à ces plantes tardivement cultivées, dont il faut forcer artificiellement la croissance, et qui réclament la protection d'une serre construite spécialement pour les abriter.

Avant tout il nous fallait nous assurer au moins la possibilité de l'expérience à tenter. Et c'était bien là notre conception lorsque

nous nous obstinions à délimiter notre champ le plus largement possible avant d'y mettre la charrue.

Voyez notre Afrique Occidentale ; longtemps nous n'avons eu d'autre ambition que de nous y assurer l'espace. Infatigablement nos explorateurs, nos colonnes expéditionnaires s'enfonçaient toujours plus avant dans les profondeurs du continent ignoré. Par nos accords avec l'Angleterre, l'Allemagne, l'Espagne, le Portugal, la Libéria, nous cédions libéralement tout ce qui paraissait à nos compétiteurs avoir quelque prix immédiat, ne nous préoccupant quant à nous que d'une seule chose—de ne pas nous fermer l'horizon, dussions-nous enfin opérer la jonction de nos possessions dans le Sahara même. Il semblait qu'il y eût je ne sais quoi d'insensé dans cette course au désert, et vous avez certainement pensé, vous pratiques Anglais, que nos hommes d'Etat prenaient plaisir, comme des écoliers, à étendre sur la carte d'Afrique des teintes agréables à l'œil ; et pourvu que notre domaine y figurât par une tache imposante, qu'importait qu'il ne comprît que des sables arides et des terres infertiles ?

Cette folie était cependant le parti le plus sage. Et si nous comparons aujourd'hui l'essor de notre Afrique Occidentale à celui des colonies voisines — même les vôtres, dont je suis le premier reconnaître et à admirer le remarquable développement— l'épreuve ne sera point à notre désavantage. Car à notre situation géographique nous devons cette condition essentielle du succès, l'unité, qui permet la convergence des efforts, la concentration des moyens, la pleine utilisation des ressources ; à cette volonté de faire grand, sans éparpiller nos forces, nous devons la constitution d'un empire cohérent, simplement organisé, coordonnant l'activité de douze millions de sujets, affectant au développement politique et économique de cette nouvelle société les ressources de budgets qui dépassent aujourd'hui quarante millions de francs.

Sans doute, le désir de regagner le temps perdu, et les conditions mêmes qui faisaient de notre œuvre coloniale, ainsi que je l'ai dit, quelque chose de nécessairement artificiel, devaient entraîner des fautes et des erreurs. Moins que tout autre je songe à les dissimuler.

Il est malaisé de créer de toutes pièces un empire colonial, une politique coloniale, une opinion coloniale. De même que cette grande entreprise manqua un peu de spontanéité, elle souffrit tout d'abord d'un défaut d'originalité. Nous avions trop les yeux fixés sur vous. Nos conceptions étaient faites de souvenirs datant du temps de notre première expansion, deux cents ans auparavant, et du désir d'imiter le modèle que vous offriez à notre admiration. C'étaient là, il faut bien le dire, de déplorables conditions, car notre volonté colonisatrice ne pouvait pas plus se comparer à la vôtre que nos possessions ne peuvent être assimilées à celles que vous aviez à cette époque mises en valeur.

L'Angleterre commerçante, industrielle, trop pleine d'hommes, devait nécessairement débuter par la colonisation de peuplement, et par l'utilisation de pays naturellement riches, capables d'un apport immédiat dans leur association à la métropole. La France agricole, sédentaire, économe, prévoyante et parcimonieuse même dans l'utilisation de son capital humain, ne trouvait pour exercer son activité que des pays ingrats, négligés, auxquels il fallait donner une valeur avant même de songer à les utiliser.

Vous aviez eu à peupler l'Amérique du Nord, l'Australie, le Cap ; vous aviez eu à organiser les Indes. Ce qui s'offrait à nous, c'étaient des terres tropicales, où l'Européen ne peut se fixer, encore moins créer une famille, et dont la population rare et misérable n'avait été capable d'aucun effort personnel. La diversité des situations eût dû conseiller la différence des méthodes. Avouons-le : les dirigeants de notre parti colonial ont mis quelque temps à s'en persuader.

Au moins leur erreur fut-elle explicable. L'attraction invincible qu'exerçait sur leur esprit le modèle anglais en est l'explication et l'excuse.

Longtemps nous nous sommes désespérés de ne pouvoir créer un mouvement d'émigration vers nos colonies ; au lieu du puissant fleuve qui avait porté la race anglo-saxonne de son large réservoir européen vers les océans des mondes nouveaux, nous nous épuisions à tirer d'une source presque tarie un mince ruisseau vite perdu dans l'aridité de sables torrides. J'oserai le dire : il est heureux que ces tentatives d'émigration provoquées et assistées par l'Etat, aient échoué ; nous eussions inutilement gaspillé la vitalité de la race en poursuivant l'impossible peuplement de pays que leur climat rend inhabitables pour l'homme blanc.

Toujours hantés au fond de la même idée, nous nous mîmes à rêver l'utilisation du sol par l'Européen ; il apporterait dans ces pays vierges son expérience, ses capitaux ; il les rendrait productifs en mobilisant à son profit la main d'œuvre indigène. Conception tout

aussi fausse, issue elle aussi de cette même conviction acceptée comme une vérité indiscutée, que la colonisation est avant tout une œuvre agricole, la mise en concession de terres vacantes, la création systématique de plantations immédiatement productives.

Il faut rendre cette justice à l'esprit français, qu'il ne s'obstine point aux expériences défavorables et que l'enseignement des faits lui donne promptement la matière de conclusions claires et générales. L'échec de nos premières méthodes fut rapidement constaté ; en dix ou quinze ans nous nous étions rendu compte de la vanité de nos essais de peuplement ; peu après nous comprenions qu'avant de songer à tirer parti d'un pays il faut l'avoir tiré du néant, et que lors même que l'on veut forcer la nature et la diriger, il faut se soumettre à ses lois. L'utilisation d'une colonie est d'abord un problème politique et social avant d'être un problème économique ; l'Etat colonisateur doit créer dans ses possessions une organisation, un état de choses qui favorise, qui suscite au besoin l'initiative des particuliers ; il ne peut décréter cette initiative.

D'ailleurs une étude plus complète des exemples qui s'offraient à nous nous conduisait aux mêmes conclusions. Chose curieuse, alors que le modèle qu'il eût été le plus naturel d'imiter, en raison de la nature de nos colonies et de l'effort que nous pouvions y tenter, eût été l'Inde anglaise, ce fut en quelque sorte le dernier qui frappa notre attention. C'est du jour où l'un de nos plus remarquables Gouverneurs-Généraux, M. Doumer, s'inspira de ce magnifique précédent, que commença la prospérité de notre Indo-Chine.

Très nettement, à la faveur de cette orientation nouvelle, se formait dans notre esprit la notion qu'une colonie vaut d'abord par son ensemble, en tant que sous l'influence du peuple colonisateur, soit directement, par l'intermédiaire de ses administrateurs, soit indirectement, par l'action de ses commerçants, elle acquiert une activité, une puissance de production et d'achat, elle s'organise et s'outille.

Mais dans cet ordre d'idées, l'évolution de nos méthodes s'ébauchait seulement. Si, pour mettre en valeur l'Indo-Chine il suffisait en quelque sorte de faire une réduction avisée et judicieuse du type plus ample de l'Inde, le problème était plus compliqué dans ces pays absolument vierges, pour ainsi dire dénués de toute valeur primordiale, qui constituaient la majeure partie de notre domaine.

Précisément parce que nous ne devions y aborder qu'en dernier lieu le problème d'une exploitation rationnelle, nous devions aussi y profiter de toute l'expérience acquise et y réussir par des solutions plus directes, plus élégantes.

L'Afrique Occidentale est le type le plus pur que nous puissions étudier à cet égard. Là, nous avons évité les hésitations et les fausses directions. L'essor de la colonie a été simple, direct et sûr. Et si j'en parle avec quelque fierté, c'est que dans cette œuvre prompte et claire je sens vivre les qualités immortelles de l'esprit français, la puissance logique qui définit le but et y proportionne les moyens, l'intelligence ordonnatrice qui assure l'économie de l'effort, la raison méthodique qui d'un rayon unique illumine l'obscurité du réel.

J'ai dit comment, dès l'origine, nous avions sauvegardé l'avenir, en assurant l'unité territoriale de notre empire. Dans son organisation progressive, le même souci d'unité devait nous guider : non point une unité arbitraire qui méconnaît la diversité des conditions particulières, mais une unité harmonieuse, qui se dégage peu à peu de l'ensemble par sa naturelle et croissante cohésion. Aux races si diverses qui peuplent nos territoires, depuis les noirs les plus arriérés jusqu'aux Maures auxquels l'Islam assure une supériorité marquée de civilisation, nous avons laissé leurs mœurs, leur organisation propre, nous bornant à régulariser, à humaniser, à perfectionner les institutions autochtones en les soumettant au contrôle de notre autorité.

Nous laissâmes tout d'abord se constituer peu à peu les groupements de villages en Province, sous l'action des administrateurs en contact quotidien avec les chefs indigènes ; les colonies particulières du Sénégal, de la Guinée, de la Côte d'Ivoire, du Dahomey et du Soudan formèrent les cadres où s'assemblèrent ces éléments en des ensembles déjà plus vastes. Maintes fois l'ébauche fut retouchée, les circonscriptions revisées, de manière à ne rien cristalliser prématurément dans un système trop rigide, et à attendre de l'expérience l'indication des affinités les plus caractérisées.

C'est en 1895 seulement qu'un essai plus large d'unification est esquissé. Le Gouverneur du Sénégal prend le titre de Gouverneur-Général ; mais ce n'est point un chef qui donne l'impulsion à tout l'appareil administratif ; c'est en quelque sorte un contrôleur permanent de l'initiative particulière des autres gouverneurs, un délégué du pouvoir central, un organe régulateur bien plutôt que moteur.

En 1902, un nouveau progrès est réalisé dans cette voie. Le Gouverneur-Général n'a plus le souci de l'Administration directe du Sénégal ; c'est nominalement seulement que quelques territoires sont placés sous son autorité immédiate, car il les gouverne par l'intermédiaire du secrétaire-général de la Sénégambie—Niger ; enfin, il dispose d'un budget distinct, très restreint encore, mais qui permet à son action de s'exercer sans prendre nécessairement l'intermédiaire des budgets particuliers des diverses colonies constituant par leur groupement l'Afrique Occidentale française.

En 1904 enfin cette organisation parvient à sa formule actuelle. Le Gouverneur-Général devient l'autorité unique et responsable qui imprime à toute l'administration son impulsion, qui concentre entre ses mains tous les pouvoirs généraux de nomination, de direction et de contrôle. Qu'il me soit permis de m'arrêter un instant sur cette conception administrative, dont nous avons fait d'autres applications heureuses, notamment en Algérie et en Indo-Chine. Le Gouverneur-Général doit être à nos yeux le trait d'union entre la métropole et la colonie ; il est placé au point où les deux intérêts qu'il doit concilier peuvent être vus sous le même angle ; assez dégagé des soucis de l'administration directe pour ne pas s'égarer dans les détails, pour conserver une notion claire de l'ensemble, mais assez éloigné du pouvoir central pour ne pas perdre le contact des réalités, pour ne pas faire prédominer les conceptions abstraites sur les nécessités pratiques, il peut vraiment incarner la métropole aux yeux des autorités locales, et représenter la colonie auprès de la métropole.

S'il dispose d'un budget suffisamment large pour lui permettre de réaliser directement ses projets d'ensemble, il ne substitue cependant point tout-à-fait son initiative à celle des lieutenants-gouverneurs placés à la tête des divers territoires et chargés d'en gérer les budgets particuliers.

En un mot, en matière coloniale, nous avons, rompant avec des habitudes séculaires d'esprit, résolument adopté la formule fédéraliste. La politique des Gouvernements-Généraux n'est pas autre chose ; et si dans la France continentale nous avons poussé la centralisation jusqu' à l'excès, l'unification jusqu' à la destruction de tout particularisme provincial, il n'en va pas de même dans nos grandes colonies, où nous avons su concilier dans une juste mesure le souci d'une souple et féconde décentralisation avec le besoin d'ordre et d'harmonie qui caractérise nos conceptions politiques. Car si le fédéralisme—permettez-moi cette critique—a reçu de larges applications dans les pays Anglo-Saxons, il s'y accompagne presque toujours d'un certain flottement dans les attributions respectives des divers organes généraux et locaux ; nous ignorons, quant à nous, les dualités d'autorité, les frottements et les confusions de pouvoir.

Un spirituel Anglais, Lord Ampthill, nous reprochait récemment, dans la remarquable conférence qu'il a faite à Paris, d'abuser pour nos colonies du vêtement de confection, taillé pour toutes sur le même patron. La critique était pleine d'humour ; mais elle n'était plus tout-à-fait de mode non plus. Nous avons cessé d'exporter nos friperies administratives. Nous avons pris à Londres des leçons de coupe et il serait juste de reconnaître que nous habillons nos colonies sur mesure, et même quelquefois avec cette élégance dont le secret reste malgré tout bien français.

Voici donc notre Afrique Occidentale sortie du néant : elle va se sentir vivre, ses organes sont prêts à fonctionner, il faut qu'une circulation économique et financière vienne l'animer, et qu'elle révèle au monde son existence.

C'est dans le budget d'un pays que se traduit essentiellement cette activité. Le budget, c'est comme le cœur d'un Etat ; toutes les parties de l'organisme social lui envoient leurs ressources ; il les leur retourne brassées et vivifiées, prêtes pour une utilisation nouvelle ; et le mouvement va s'accélérant ; c'est la prospérité, c'est la civilisation, c'est la puissance et le progrès.

De bonnes finances sont à la base de toute bonne politique. Ce n'est pas à des Anglais, n'est-ce-pas, que j'apprendrai cette vérité. Et je suis heureux de pouvoir leur dire quelques mots des finances de l'Afrique Occidentale, quelques chiffres plutôt, plus éloquents que des phrases.

L'ensemble des budgets de notre grande colonie, abstraction faite des budgets municipaux, s'élevait en 1895 à 10,518,782 frs. Il était, en 1906, de 42,285,824 frs.

Aucune interruption, aucun heurt dans ce naturel développement des ressources générales, qu'une pénétration de plus en plus intime du pays conduisait simplement à mieux recueillir et à mieux utiliser. Les impôts rentraient toujours au-delà des prévisions, et les dépenses restaient inférieures aux recettes, permettant l'affectation immédiate des disponibilités à d'importants travaux d'utilité générale, en même temps qu'une capitalisation

partielle des excédents dans les caisses de réserve. L'avoir de celles-ci, qui était, au 30 Juin 1895, de 1,860,143 frs., atteignait, au 30 Juin 1906, l'imposant total de 10,667,453 frs.

Le système budgétaire et fiscal de l'Afrique Occidentale est d'ailleurs aussi simple que son organisation administrative. Il s'inspire des mêmes principes. Chacune des colonies de la fédération a son budget distinct, qui supporte ses frais d'administration propre, ses dépenses d'intérêt nettement local.

La fédération elle-même a son budget, le budget du Gouvernement-général, ou budget général, superposé aux budgets des colonies, complètement séparé d'eux, affecté exclusivement aux dépenses de l'administration commune, à l'exécution des projets d'intérêt général.

Tout ce système, hâtons-nous de le dire, fonctionne sans un centime de subvention de la part de la métropole, qui se borne à faire les frais de l'occupation militaire et de la défense extérieure — frais pour lesquels la colonie lui paie déjà une part contributive de 300,000 frs., qui s'augmente actuellement de 100,000 frs. chaque année. C'est exclusivement des ressources locales que l'organisme financier de l'Afrique Occidentale tire toute sa sève; et il la puise essentiellement par deux racines principales; l'impôt de capitation d'une part, impôt direct sur la personne de l'indigène, et, d'autre part, les droits d'entrée et de sortie, impôts indirects à forme douanière.

Ces deux principaux revenus ont une affectation distincte. L'impôt direct alimente les budgets des colonies distinctes,l 'impôt indirect est versé au budget général; conception d'ailleurs parfaitement logique. Le contribuable doit voir dépenser sous ses yeux, dans son intérêt immédiat, l'argent qu'il verse en personne au Trésor; l'impôt direct, surtout l'impôt de capitation, dont l'incidence est précise, doit avoir une utilisation aussi précise. L'impôt indirect, au contraire, est payé par la collectivité plutôt que par l'individu; il naît à l'occasion du mouvement de la richesse; il doit donc servir aussi à un but général, et être utilisé à accélérer le mouvement qui crée la prospérité de chacun par la circulation des valeurs.

Pour donner une idée de l'importance de ces divers produits j'indiquerai les réalisations constatées par le compte de 1904.

Le total des impôts indirects s'élève à 13,231,713 frs. sur lesquels les droits d'entrée et de sortie représentent à eux seuls 12,738,673 frs.

Et cependant ces taxes sont des plus modérées; le tarif atteint généralement les marchandises françaises à peu près dans la même proportion que les marchandises étrangères, et le commerce supporte aisément cette charge, dont il bénéficiera d'ailleurs en fin de compte, puisque le budget général consacre la majeure partie de ses ressources au développement de l'outillage économique. D'ailleurs, vos possessions de l'Ouest Africain, dont les exportations et importations totales sont plutôt inférieures à celles de notre Afrique Occidentale, ne demandent-elles pas à leurs douanes 20 millions de recettes, soit près de 7 millions ½ de plus que notre grande colonie?

Le total des impôts directs prévus aux divers budgets s'élève, d'autre part, à 13,805,440 frs., sur lesquels l'impôt de capitation rapporte à lui seul 12,635,093 frs. Et notons que les taux restent toujours extrêmement modiques, que le tarif ne dépasse pas 4 frs. par tête dans les régions les plus fortunées, et tombe à fr. 0·25 dans les cercles les plus pauvres,—que de larges dégrèvements sont accordés,—qu'enfin une bonne partie de la population échappe encore à l'impôt. Si l'on considère que nos possessions doivent renfermer au minimum 12 millions d'habitants, nombre destiné à s'accroître, et qu'il n'est pas exagéré d'espérer que d'ici peu d'années le taux de 4 frs. pourra être appliqué partout, on est conduit à penser qu'un rendement d'impôt de 40 à 50 millions est à atteindre.

Cette prospérité financière devait asseoir le crédit de la colonie. Popularisée par son rapide essor, par l'active propagande que lui faisait son éminent Gouverneur-Général, Monsieur Roume, l'Afrique Occidentale pouvait songer à faire appel aux capitaux pour s'aménager et constituer son outillage.

La France a su, dans cet ordre d'idées, imiter heureusement l'exemple qu'encore une fois l'Angleterre lui donnait. On calcule que celle-ci a prêté, je crois, plus de 10 milliards à ses colonies: placement avantageux, et pour les pays neufs qui ne demandent qu'à être commandités pour faire bonne figure dans le monde, et pour la métropole, qui ne peut faire meilleur usage de ses réserves de puissance économique, que de s'en servir pour susciter l'éclosion de forces nouvelles.

Sans débours, en donnant simplement son aval à la colonie, la France a ouvert à celle-ci les inépuisables trésors de l'épargne nationale. Par deux fois, en 1903 et en 1907, elle a garanti des emprunts, l'un de 65 millions, l'autre de cent, et ce pays né d'hier a pu

trouver des prêteurs au taux de 3 %, et au cours de 92·50 %.

Ce large apport de capitaux, voilà l'œuvre essentielle, la véritable action motrice qui décida du sort d'un pays. La colonisation, c'est par-dessus tout une large entreprise, une opération de placement, le lancement d'une raison sociale et politique nouvelle. L'émigration des hommes n'est presque rien ; l'emigration des capitaux est tout.

En Afrique Occidentale, nous en voyons un frappant example. Ce pays compact, fermé et comme hostile à toute pénétration, n'avait reçu de la nature ni fleuves à débit régulier, ni côtes largement développées, ni ports hospitaliers. Il fallait artificiellement lui donner ces voies de communication, ces points d'appui, ces têtes de ligne du mouvement commercial.

C'est là ce qu'a compris admirablement le Gouverneur-Général Roume. Il se fît l'apôtre de la pénétration par le rail, démontrant avec une saisissante netteté que les chemins de fer devaient tenir lieu et des routes inexistantes et des fleuves rebelles à toute navigation régulière.

Lorsque cet éminent administrateur arriva dans la colonie, en 1902, il trouvait, à côté de la ligne Dakar-Saint Louis, terminée depuis 1885, et longue de 263 km., un tronçon de 290 km. environ livré à l'exploitation sur le tracé depuis longtemps projeté Kayes-Bammakou.

Quatre ans plus tard, grâce à l'impulsion énergique donnée par l'emprunt de 65 millions, la longueur des lignes exploitées s'élevait à 1,366 km., presque le triple du chiffre de 1902. La ligne de Kayes au Niger, achevée dès la fin de 1904, fonctionnait sur toute sa longueur de 567 km., les lignes de Guinée et du Dahomey poussaient vers l'intérieur des artères déjà longues de 263 km. et de 267 km., et la ligne de la Côte d'Ivoire s'avançait déjà à 58 km. du terminus sur la côte.

Dans cinq ou six ans, lorsque les fonds du nouvel emprunt de 100 millions auront été affectés à la continuation de ce vaste programme, qui fait converger de la côte vers l'intérieur des voies tracées à peu près suivant l'axe de chacune des colonies—dans cinq ou six ans, dis-je, le réseau exploité fournira un développement de 2,392 km.

Et cette œuvre que j'ose qualifier de gigantesque, eu égard aux moyens d'action mis en œuvre, se sera accomplie presque sans mécomptes à des prix de revient peu élevés, puisque le Dakar-Saint Louis a coûté en moyenne 77,000 frs. le kilomètre, le Kayes-Niger environ 80,000 frs., le chemin de fer de la Guinée 96,000 frs., celui de la Côte d'Ivoire 90,000 frs., et celui du Dahomey 95,000 frs.

Sur toutes ces lignes, dès leur ouverture à l'exploitation, l'activité du trafic a dépassé aussitôt toutes les prévisions. Le Dakar-Saint Louis, ligne stratégique qui traversait un désert, a dû être reconstruit, à peine établi, parce que l'activité de la circulation compromettait la solidité de l'ouvrage, conçu pour un trafic bien inférieur aux premières réalisations ; le long des rives du fleuve d'acier, des champs se sont plantés, des exploitations se sont créées, une plaine fertile a remplacé le désert. De même en Guinée, au terminus provisoire du tronçon en construction, une ville nouvelle est sortie de terre en moins d'un an ; c'est Kindia, la capitale peut-être de demain. Même phénomène auprès de Kayen-Niger, construit lui aussi, comme le Dakar-Saint-Louis, dans un but stratégique, et sur lequel, au lendemain même de l'inauguration, commençaient à circuler les tonnes d'arachides.

Les chemins de fer ne font pas, comme les anciennes routes de portage, le vide autour d'eux ; bien au contraire, ils attirent les populations vers leurs rives. Poussés par la grande loi du moindre effort, qui leur faisait fuir jadis l'odieux esclavage des transports à tête d'homme, les noirs accourent vers le rail, qui leur apporte l'aisance et les facilités du progrès.

Tous ces efforts ne pouvaient manquer de produire leur résultat, de se matérialiser en une prospérité tangible. Les chiffres des statistiques sont là pour l'attester.

Le mouvement commercial de l'Afrique Occidentale était, en 1895, de 78,777,336 frs. En 1905—et c'était une année de crise—il avait doublé, et atteignait 153,073,896 frs. Les résultats de 1906 doivent être supérieurs à 156 millions, chiffre obtenu en 1904. Importations et exportations se développent parallèlement, passant les unes de 46,882,773 frs. en 1895, à 90,913,422 frs. en 1904, et les autres de 31,894,583 frs. en 1895, à 65,038,881 frs. en 1904. L'on remarque même que proportionnellement ces exportations se développent plus rapidement par les importations, et rien ne prouve mieux que cette prospérité n'a rien de factice, qu'elle tient à une réelle et foncière augmentation de la valeur propre du pays.

Le mouvement commercial avec la France représente à peu près exactement la moitié du

mouvement total. Ce résultat montre que, contrairement à une croyance trop répandue, le régime du libre-échange n'est pas spécialement funeste à notre commerce, et qu'en tout cas, la politique dite de la "porte ouverte" est, aux colonies, la formule féconde et vraie. Je suis certain que mes auditeurs anglais enregistreront volontiers cet aveu, venant d'un Français protectionniste. Nous reconnaissons de jour en jour que si la métropole, comme je l'ai dit ailleurs, peut avoir besoin pour son organisme vieilli du corset des tarifs douaniers, les colonies, organismes jeunes, veulent le grand air de la liberté, qui leur permet de respirer, de grandir, de se former.

Nous ne devons pas pousser leur croissance. C'est par leur existence même, par les mille occasions de profit que leur prospérité propre est pour nos nationaux, par les ressources et les prétextes d'action qu'elles leur offrent, que les colonies acquièrent leur vraie valeur. Toute réglementation arbitraire, toute tyrannie, soit politique, soit économique, porte en soi sa condamnation.

Nous touchons au terme de l'effort colonial.

Grâce à notre expérience Africaine, nous croyons maintenant mieux comprendre quel but il convient de se proposer, quels moyens il importe de mettre en œuvre. La colonisation, c'est essentiellement la création d'un pays, c'est la science politique venant en aide à la nature pour faire une nation nouvelle.

Parfois, cette nation, il faut en tirer les éléments du sein même de la métropole ; c'est la colonisation de peuplement. Parfois l'on en trouve l'organisation réalisée par avance, et il suffit de discipliner les hommes, de leur donner des cadres sociaux, de leur créer une nécessité d'action ; c'est la colonisation de domination. Parfois enfin il faut prendre les matériaux à pied d'œuvre, aménager le pays, former le peuple qui doit en tirer parti, fournir à cette humanité nécessaire la vitalité qu'elle n'a pas su tirer en soi, dégager son génie propre qui s'ignorait lui-même, l'éduquer par la pression d'une volonté plus haute, plus puissante et plus éclairée : c'est ce que je voudrais appeler la colonisation de création.

De la première et de la seconde, vous nous avez donné d'admirables modèles. Laissez-nous espérer que la troisième sera plus particulièrement une spécialité française, et que notre Afrique Occidentale en sera le premier type complet.

Cette œuvre-là nous sera particulièrement chère. Elle ne demande pas seulement de l'intelligence et de la force. Elle veut de la bonté.

Rien n'est possible dans ces pays tropicaux sans le capital humain qui seul peut leur donner une valeur par son travail, et ce capital, nous ne pouvons le demander qu'aux races autochtones. Elles sont si faibles, si misérables, qu'elles paraissent exister à peine, et qu'avant de songer à les utiliser, il faut songer à les protéger, à les faire vivre, à deviner leurs mérites et leurs aptitudes.

L'Angleterre a été l'initiatrice de la politique à suivre à l'égard des indigènes ; elle a su respecter leurs organisations propres et leurs mœurs traditionnelles, elle a su les faire vivre à l'aise au milieu de la paix anglaise.

Mais il nous faut mieux faire encore. Car les indigènes dont nous avons la charge, il ne suffit pas de les protéger, il faut les secourir ; il ne suffit pas de leur assurer la liberté, il faut leur créer une activité ; il ne suffit pas de vouloir respecter leur existence propre, il faut les aider à prendre conscience d'eux-mêmes.

En Afrique Occidentale, nous ne nous sommes pas bornés à proscrire tout esclavage, tout asservissement même temporaire de l'homme par l'homme ; nous avons assuré à l'indigène la reconnaissance et la protection de sa propriété par le système de l'immatriculation, imité de l'Act Torrens. Nous lui avons crée une organisation sociale faite à la mesure de son intelligence ; nous lui assurons une justice conforme à ses instincts, qui n'avaient même pas su s'exprimer en des institutions précises. Nous le provoquons à tenter des cultures pour son propre compte, à s'essayer à des métiers faciles, à se créer une richesse et des besoins.

Ce qu'il faut maintenant, c'est protéger directement sa vitalité, développer sa natalité, en lui assurant les bienfaits de l'hygiène et en lui fournissant une large assistance médicale. Cette grande œuvre est en bonne voie, et le programme de l'emprunt de 100 millions prévoit l'affectation de 3 millions à la création de postes sanitaires au milieu même des populations noires.

Permettez-moi de m'arrêter sur cette idée que la colonisation est avant tout une grande œuvre de fraternité humaine.

Je voudrais que ma patrie fût l'ouvrier de cette tâche, l'avocat de cette cause.

Elle le doit à tout son passé. Elle en est digne par son ardent amour de l'humanité, par son ardente contribution à la diffusion de la justice et de la liberté dans le monde.

Ces idées je ne craignais pas de les développer il y a six mois, devant un public allemand, à Berlin. Il me semblait qu'entre

peuples civilisés, maintenant que pardessus nos querelles s'élève la conception du rôle mondial des nations blanches, il est nécessaire de chercher les voies d'une large coopération. L'ère de la politique européenne peut se clore demain ; celle de la politique mondiale s'ouvre seulement ; tels intérêts qui semblaient hier incompatibles, se concilieront peut-être sans peine sur ce théâtre plus vaste. Si la France et l'Allemagne demeurent l'arme au pied, si la tristesse des souvenirs, la noblesse du devoir patriotique et l'orgueil de la victoire maintiennent toujours debout les obstinées sentinelles de la grandeur continentale, du moins tout leur effort ne s'immobilise plus tout entier sur la frontière tragique. L'une a les yeux tournés vers cette Afrique du Nord, qui sera demain son vrai domaine, son prolongement territorial ; l'autre regarde vers l'Est où tous ses intérêts l'appellent, où son expansion naturelle suit des voies pour ainsi dire tracées d'avance.

Je suis heureux de répéter devant vous ma confiance en ces temps nouveaux. Mieux que d'autres encore, parce que vous êtes des colonisateurs nés, parce que le theâtre de votre action fut toujours l'univers, parce que vous y occupez des positions dont nul ne songerait sérieusement à vous déloger, mieux que d'autres vous pouvez travailler à la réalisation de cet avenir.

C'est parce qu'elles l'ont l'une et l'autre clairement entrevu, que nos deux patries marchent aujourd'hui côte à côte, la main dans la main.

Car l'entente cordiale, ce n'est pas le rapprochement d'intérêts égoïstes, c'est l'union des deux plus grandes forces de progrès qui aient jamais agi sur l'univers.

Les deux races ne sont pas seulement attirées l'une vers l'autre par une naturelle sympathie ; elles ont le devoir de coopérer, parce qu'elles se complètent.

La hardiesse anglaise et la sagesse française, l'action et l'idée, la volonté et la raison, quel obstacle pourrait s'élever contre une telle association ?

Angleterre et France ne sont-elles pas les deux artisans du monde moderne, les patients et laborieux ouvriers de la civilisation présente ?

Songeons que leur rapprochement a été salué comme une sauvegarde par la grande communauté des peuples. Songeons que leur coopération a été comprise comme une promesse à laquelle nous ne saurions manquer.

Travaillons donc, par la diplomatie, par la colonisation surtout, à grouper autour de ce centre solide des éléments de plus en plus nombreux. Convions à l'œuvre commune toutes les bonnes volontés.

Permettez-moi, mesdames et messieurs, de m'approprier en terminant l'une de vos formules pour unir ma foi coloniale à votre large patriotisme : en travaillant pour la "plus grande Angleterre," préparez la "plus grande entente cordiale," celle qui réunira toute la famille humaine dans un monde où la paix règne, où la justice habite.

DISCUSSION.

Mr. BERTRAM COX, C.B., on behalf of the Colonial Office, of which he said he was a member, desired to express to the author their warmest appreciation of the interesting and inspiring address he had delivered. He did not think it would be posslble to put into better terms, than those employed by the author, the principles which must guide any civilised Powei in its colonising work. He had stated that the duty of a nation which was colonising a tropical dependency with savage tribes, was to prohibit slavery and every compulsory subservience of one man to another, to assure the native of the protection of his property, and to give him organisation suitable to his needs. That being the first duty of a colonising and civilising nation, its second task, in the author's opinion, was to give the native an outlet for his industry, and to create new needs which the colonist, who came to administer his country, would profit by. In the past the latter idea had often come first, the person who went out to deal with the natives, thinking of his own interests first and afterwards those of the natives themselves. But the gradual evolution of colonisation and civilisation had brought every civilising race to see that its true interest lay in the process which the author had detailed in such eloquent and succinct terms ; and he thought the members should be grateful to him for laying down that main principle at the end as well as at the beginning of his address. The author had perhaps been rather too complimentary to England and English methods of colonisation. Englishmen in the first place inhabited by settlement places like Australia, New Zealand, and Australia, where white people could live, and subsequently in the same way undertook the colonisation of tropical countries. He did not allude to India, but more especially to the work of the Colonial Office, and there the difficulties which had confronted France had also confronted them. The English worked more by instinct, and the French, as might be expected, more by reason. They set to work, as was so natural to French genius, to formulate for themselves, in their own minds, what the principles of colonisation should be. In the early days when the English colonisers were not interfered with from home they managed to work the problems out for them-

selves. They were successful to some extent, because they were working at a time when the telegraph was unknown. There was not so much tendency at first on the part of the home Government to interfere, and also not so much tendency on the part of the man on the spot to appeal for help to those who were his superiors at home. The absence of the telegraph was beneficial in both ways—it taught the man on the spot to rely on himself, and it prevented the man at home from interfering too much. The man at home had now learnt to interfere only in essentials; but there were certain matters, such as the spending of Imperial funds, and dealing with questions of large principle, where it was necessary for him to make his voice heard. The tendency of British colonisation, however, was certainly to leave local details, as much as possible, to the man on the spot, and he was glad to hear the author say that exactly the same tendency prevailed in France. A little while ago he was associated with three eminent men in the Colonial Administration of France in negotiating a Convention which had just been brought into force with regard to the New Hebrides, and he had been surprised to find how much there was in common between France and this country in matters of colonisation, and how little there was on which the two countries did not work practically on the same lines. In discussing the legal organisation which should be put in force in the Islands, neither party knew very clearly what the procedure of the other was; but when the matter was worked out it was found that the regulations were practically the same. Exactly the same occurred when the minor details of colonial organisation were worked out. He desired to make those remarks, because there was a tendency sometimes to suppose that England and its colonising neighbour worked at opposite poles in the colonisation field. As a matter of fact, they were much nearer together than was formerly supposed by people who discussed colonial questions. He also desired to express his appreciation of the remarks the author had made on the great influence of railways. England had been rather late in the field in that direction, acting too often on the idea that the merchandise should be available first and the railways built afterwards. When the Canadian Pacific Railway was projected, there were people who prophecised that it would not earn sufficient to buy grease with which to grease the axles; and the same idea had limited what had been done in that direction in tropical dependencies. France had set this country an example by the pioneer railways she had built in West Africa, for which England ought to be extremely thankful. The Uganda Railway was a case in point. It was said that it would never pay, and for a long time it did not, but it was now paying its working expenses and something besides. It showed the foresight which French politicians possessed when they reasoned out that it was of extreme importance to make railways, in the certainty that, sooner or later the traffic would come to them if they were there to take it. England was following France in that respect in her tropical dependencies, and at the present time a railway was being projected from the Niger to Kano. He wished, in conclusion, to express his very hearty thanks to the author for his most illuminating address, the effect of which would not cease within the confines of the lecture-room or the *Journal* of the Society, but would be a matter of moment to both public and official men who had the interests of tropical countries and colonisation at heart.

Mr. C. Rozenraad remarked that the chief question to be considered was not so much the railways as the goods and raw materials to be obtained. The Colonies were necessary for our existence, as we required their productions, and their increasing population gave an outlet for our manufactures.

The Chairman (Sir Owen Tudor Burne)—M. Hubert has told us that if there is a subject which a French speaker might have some misgivings in bringing before an English audience, it is that of the method of colonisation I think that, after his business-like and clear address, we may assure him that we have learnt much from him this evening, and that he has given us a great deal of important matter for our study and consideration. The French provinces in West Africa, which consist of something like 520,000 square miles, with a population estimated at about 12,000,000 people (provinces which we denote in this country by the general name of Senegambia) are evidently well-administered, progressive, and flourishing; and no one can rejoice more in this favourable condition of things than we Englishmen, more especially as our relations with the French in that part of the world are of a most friendly character; and recognising, as we do, that we cannot have better neighbours in that part of the world than the great nation which M. Hubert represents on this occasion. It must be a source of gratification to us that M. Hubert points to India as a country which may be regarded as a type of administration worthy of study, and indeed of imitation, by other nations in the establishment of new colonies; and I am personally glad of his friendly praise, as one who has resided in that part of the world in past years, and who considers that, with all its faults here and there, it is one of the best administered parts of our Empire. At any rate, we endeavour to carry out in our Indian possessions those principles to which he alludes, of leaving intact, as far as possible, the customs, the religions, and the various organisations of indigenous populations, regularising and humanising their inherited institutions while bringing them under control and teaching them to be of political and commercial value. This can only be effected, as M. Hubert truly points out, by goodwill and kindness, added to intelligent and effective rule. We shall, I think, all agree cordially with M. Hubert in the kind and

impressive sentiments that he expresses towards the close of his address, that the *entente cordiale* between England and France need not be a joining together of mere selfish interests, but a union of two great pioneers of progress which should make itself felt in the world at large.

M. Hubert, au nom de la "Society of Arts" et de cette assemblée, je vous prie d'agréer nos remerciements sincères pour votre résumé, si intéressant et si saisissant, du rôle qu'a joué la France dans l'Afrique Occidentale. Votre discours, plein de renseignements les plus utiles, sera publié dans un prochain numéro du *Journal* de notre Société, un *Journal* qui circule par le monde entier. Il sera, donc, lu d'un grand nombre de membres de la Société qui se sont trouvés empêchés d'assister à notre séance de ce soir, et je tiens à vous assurer qu'il sera apprécié de tous côtés, à cause egalement de ses descriptions si vivantes, et de la façon spirituelle dont vous avez su parler de la position qu'occupe votre grand pays dans l'Afrique. Je ressens un plaisir tout particulier de présider cette réunion, quand je pense que j'ai combattu il y a cinquante deux ans (plus d'un demi-siècle, hélas!) côte à côte avec l'armée magnifique de France, et que je retiens de ce temps le respect le plus cordial de la France, de son armée, et de son brave et généreux peuple. A cette heure avancée je ne puis passer en revue tous les détails que vous nous avez rappelés, mais je tiens à vous remercier, encore une fois, de l'heureuse inspiration que vous a mené près de nous ce soir, et d'exprimer les vœux les plus sincères pour que la France et l'Angleterre, à jamais unies par les liens de l'amitié les plus fermes, puissent assurer, par leur co-opération, le progrès et la paix du monde.

Mons. HUBERT, in acknowledging the vote of thanks said:—Je suis plus touché que je ne saurais le dire de l'accueil si sympathique, si cordial et si chaud que vous avez bien voulu me faire ce soir. Je ne suis qu'un modeste citoyen français, et je suis heureux de voir, dans les paroles si éloquentes et si pleines de cœur que prononçait tout à l'heure votre Président, que c'est la France que vous avez bien voulu voir dans un de ses enfants. C'est le pays qui, avec le vôtre, comme je le disais tout à l'heure, forme l'ensemble le plus logique et le plus naturel. Dernièrement, le conférencier anglais Lord Ampthill nous disait dans un toast, ces choses charmantes: "Ce que nous avons le plus envie de vous, c'est ce que nous ne pouvons pas vous prendre; c'est la qualité inhérente à la race française"—je vous rends le compliment. Ce que nous aimons le plus en vous, c'est la ténacité dans l'action, cette soudaineté de réalisation dans le but que vous entreprenez. Je vous remercie d'avoir bien voulu indiquer que nous avons raison de multiplier les relations comme celles qui m'amènent aujourd'hui parmi nous, et j'espère bien, pour mon pays et pour le vôtre, que cette suite de conférences que Lord Ampthill inaugura à Paris aura un lendemain; car c'est une façon de causer; causons c'est le mot. Si chacun cause chez soi c'est un monologue; aujourd'hui nous avons entamé le dialogue: j'espère qu' il durera longtemps. Je remercie votre Président de l'expression de son bon souvenir de la France.

THE FRENCH RIBBON INDUSTRY.

The production of ribbons at St. Etienne amounted in value, in 1906, to £4,000,000, being an increase of £750 over the previous year. The value of the exports was somewhat over £1,250,000, or an increase of £400,000 as compared with 1905. Ribbons are exported from St. Etienne more or less all over the world, but the countries which are the largest purchasers are England, Germany, United States, Canada, Argentine Republic, China, Italy, and Spain. The present number of looms in St. Etienne and the vicinity is estimated at 75,000. The number of ribbon manufactories is about 170, but they are not all confined to the city, a large number being scattered through the small towns of the Departments of the Loire, Haute Loire, and the Isère. According to the American Consul at St. Etienne, within the last few years electric motor power has been distributed, not only to the large ribbon factories of the region, but also to every weaver who works at home. Hitherto the weavers who generally possess from two to three looms, did all the work by hand, but now hand-made ribbons may be considered a thing of the past. The output has consequently increased, and the wages are a little better than some years ago. The weavers, as a class, are sober and intelligent men, living frugal lives, and they seem totally absorbed in their trade. A large number are not only proprietors of their looms, but also of their houses, and it may be said that many quarters of St. Etienne were built by them. A model weaver's home consists of three rooms, one long and large enough to contain three looms, two family rooms, one of which is the kitchen, eating, and bedroom combined; the other is the bedroom, and contains the best household furniture. The homes are always clean and neat, presenting frequently a contrast with those of workmen of other trades. Their diet consists of soup, morning and evening, made of a curious mixture of bread, potatoes and cabbage, to which a slice of bacon is added to give it a flavour. The dinner is composed of meat, vegetables, cheese, coffee, and a quart of red wine, while the supper is made up of soup, the remainder of the dinner and the usual bottle of wine. As will be seen the French weaver lives fairly well, but without any extravagance. The earnings of a weaver are difficult to calculate, but five shillings and sixpence per day may be considered as an average for the year round. At some seasons he will earn as much as eight shillings and sixpence to twelve shillings and sixpence a day, while at others he will not make more than two shillings and sixpence, or his looms may be idle for a few days. In the factories the work is more regular, but frequently short time is imposed for obvious reasons. The ribbon industry, depending entirely on

the caprices of fashion, is subject to constant fluctuation. The prominence given to St. Etienne in the production of ribbons is due to two factors, one of which is the nature of its water, which, free from any mineral substance is chemically pure, and excellent for dyeing purposes. It is thus that the most delicate shades or tints can be produced to almost perfection. The number of dyeing establishments in the city of St. Etienne is 21, and those houses not only supply the local needs but execute large orders from Lyons and elsewhere. The second reason is that of the well-known special aptitudes of the weavers The weaver of St. Etienne is by nature an artist in his trade. Handed down from father to son, all the secrets of the industry, the delicate manipulation of the threads on the looms, and the varied combinations of the design to obtain the most artistic effects are and will remain the distinctive and attractive features of the St. Etienne ribbon industry. St. Etienne, with its 150,000 inhabitants, possesses other industries, which, although less known perhaps than ribbon making, yet are sufficiently important to give employment to thousands of workmen, and contribute materially to the prosperity of the city. Among these may be mentioned coal mines, iron and steel foundries, gun making, hardware of various kinds, bicycles, &c.

NORWEGIAN OYSTER CULTURE.

The interest in oyster culture in Norway, owing to successful experiments, appears to be steadily growing, and the number of new oyster breeding grounds increases year by year. The work in artificial culture falls into two main categories—collecting the fry in spat pools and breeding on fattening grounds. The former comes first under consideration. In the form of larvæ, oysters swim about freely in the water for a certain length of time. When the larval development is at an end they attach themselves to some stable object, and begin their reproductive life. For many years past it has been a well-known fact that oysters, in certain specially warm pools along the coast, were capable of producing an enormous amount of spat, and that first and foremost it was necessary to collect this in a satisfactory manner, as the bottom of the so-called spat pool is for the most part covered with soft mud, and a large quantity of the spat was lost where care was not taken to provide sufficient stationary objects to which it might attach itself. This is now done by hanging out bundles of twigs on iron wires stretched from the one shore of the pool to the other. The American Consul at Bergen says that these twigs are usually known as collectors. The twigs may be bound together in various ways, either by simply fastening them together in bundles like a broom, or the twigs are bound together between two wooden laths, so that they form a sort of flat wall. The material most frequently used is birch twigs. As the spat sooner or later must be plucked off the collectors, birch twigs have the great advantage that the bark is easily loosened, and is brought with the fish, by which separating them is avoided. Moreover, separation is not easily accomplished, as spat generally fastens itself very firmly to the object to which it has once become attached. The twigs are generally of the thickness of broom twigs, and are cut in winter, when the sap is at rest. Newly cut they are of no use, for the spat will not settle on them. The twig bundle collector is from three feet and a quarter to six feet and a half long. In order to sink it a stone is fastened among the twigs in the bundle. The iron rods to which the twigs are attached are usually bent round like a hair pin, so that they enclose twigs on both sides. The twigs are fastened on with steel wire or spun yarn. Formerly, instead of iron rods, laths were used, in which case sinkers had to be fitted to the collectors, for which purpose tiles were usually employed. Where iron rods are used, the collectors, as a rule, are heavy enough without any extra sinkers. The collectors are hung out in the spring. The largest quantity of spat is deposited on them in the summer. In general, the fry is left quiet till the following spring—April or May. The raising of the collectors with the fry attached is usually accomplished from a boat, or from a raft specially constructed for the purpose. Transport cases, in which fry when detached can be placed and despatched, are placed temporarily, before sending off to the fattening grounds in the sea, and not in the pools. The cases float on the surface, and, as the surface water of such pools contain, as a rule, a small proportion of salt, the fry would be injured if left lying there for any length of time. The method now almost exclusively adopted, and here described, is the system of breeding in baskets suspended in the same way as are the spat collectors. Baskets are always made of galvanised wire netting. Fry which is fit to be set out to fatten, when it is nearly a year old, is generally $1\frac{1}{16}$ inches in size. For this reason, baskets at first are used of different-sized mesh. The finer meshed the netting used the dearer is the basket. Three different sizes of mesh are used, three-fourths, one-fourth, and three-eighths inch. As the fry grows it must be distributed in several baskets of large mesh. From this it follows that the baskets of finest mesh are superfluous, and need not be used except to make provision for sending out young fry to the fattening ground. A fine-meshed basket of three-eighths inch net may, therefore, be counted on to do its work for a couple of years longer than those of coarse mesh, which are in use throughout the entire year. A basket of from three-fourths to one-half inch net has been calculated by experience to be serviceable for from three to four years, which corresponds to the number of years which fry in the generality of the Norwegian grounds need in order to attain a saleable size. On this, as is easily understood, depends in a considerable degree the vitality of the basket system. Baskets are suspended in the same place as the twig collectors, a couple of yards from the surface, on wire stretched from one shore to the other. The fry is taken off

from the spat pool when from three-fourths to one year old, that is, in April or May, and is immediately set out in the place where it is to be fed. The following space allowance may be taken as a general rule :— Of three-fourths to one year old oysters, from 300 to 100 in a basket, and of three to four years about 100. Instead of plucking the fry off the collectors and carrying it to the fattening ground in cases, it is also sometimes the custom to hang out the twigs together with the fry in the place where it is to feed, and only after a year, when the fry has grown and the twigs begun to be brittle is the fry picked off and laid in baskets. This method is very practicable when there are no worms in the twigs. The fry is regularly inspected, and the basket kept free from weeds; the fry is also provided with sufficient room in the baskets, distributing them among different baskets when they grow, so that they may never lie one upon the other, and the baskets watched to see that they do not hang crooked, whereby the fry might be thrown together in a heap. In all the places in Norway where experiments have been arranged, it is the intention of the property owners and those interested to go on with oyster culture, to purchase fry and plant it out. Not only those owners on whose lands the experiments are being made are thinking of seriously engaging in oyster culture, but also many other landowners have asked that similar experiments should be made on their property.

THE CHINESE SILK TRADE.

Shantung is one of the largest silk-growing provinces in China. It has been predicted ever since the opening of the port of Tsingtau that when the railway was finished, which connects the silk districts in the back country with the port, the silk trade which had previously centred at Tientsin and Chefoo would be diverted to Tsingtau. According to the United States Consul at Tsingtau, the annual silk trade of the port is increasing, but the building of the railway has not made the enormous changes that were expected, principally owing to the fact that large silk-spinning establishments have been established in Tientsin and Chefoo for many years, and that the regular trade routes are through these cities. Shanghai has always been one of the largest silk markets of China, and it appears that a considraable quantity of the silk produced in Shantung is now being sent to that city by way of Tsingtau. During the year 1906 the Shantung railway carried 210 tons of silk coastward, which otherwise would have taken the overland routes to Chefoo or Tientsin. In the Liu-t'ung or Chang-i district is a most important manufacturing centre; its annual trade is valued at about £1,160,000. It is the principal market for the "wild raw silk," as it is called by the trade. The Ching-chou district produces silk to the value of £300,000, chiefly at Wu-ching and Yeh-yuan. The trade of Chon-ts'un is estimated at £2,170,000. The produce of these three places (Liu-t-ung, Ch'ing-chon, and Chon-ts'un), especially in silk cocoons and pongees, is nearly all conveyed by cart or pack animals, even that portion going to Chefoo. It is possible that the predictions will still be realised, as the railway has been in operation only about two years, which is hardly sufficient time to divert a trade to a new route from that which has been established for half a century.

WOLFRAM.

During the past few years the price of tungsten ores and metallic tungsten has much increased, but notwithstanding this the output has not increased in anything like proportion to the growing demand, and firms requiring large quantities of tungsten have had difficulty in obtaining supplies to guarantee future deliveries. There has been considerable discrepancy in the prices paid for ore as there always is when it is produced spasmodically in widely separated and little known localities where the isolated, small producers, having little chance of becoming acquainted with market conditions are at the mercy of the buying firms who control the manufacturing and selling monopoly and consequently make enormous profits. The apathy of the Sheffield firms in this matter is surprising. Their inaction may hereafter cause them to lose the manufacture or the monopoly of tungsten steels, which may pass into the hands of their more energetic American competitors, who are acquiring the ore deposits. The market for tungsten ore is still expanding, and according to a recent bulletin of the United States Geological Survey, seems now to be almost as sure as the market for copper and other staple ores. Prices during the past year have varied from 21s. to over 50s. (depending on quality) per unit for ore containing tungsten acid.

The chief ores of commercial importance are wolfram and scheelite, the former a tungstate of iron and manganese, containing up to 76 per cent. tungstic acid, the latter tungstate of lime containing up to 80 per cent. tungstic acid. The greatest producing locality in the United States is Boulder, County Colorado, where the ore occurs as a wolframite breccia. An analysis of the crude ore from the most important deposit yet discovered in the United States near Crescent City, Colorado, gave tungstic acid 39·7 per cent., FeO 12·8 per cent., MnO 6 per cent., insoluble matter 42·3 per cent. In commercial working, it would be easy to produce a 60 to 65 per cent. tungstic acid concentrate from this deposit.

It has long been known that wolfram was associated with tin ores in Cornwall, but until recent years it has not been separated to any extent. Magnetic separation was introduced some years ago, and some measure of success in the separation has been attained in various mines. Wolfram is feebly magnetic, and requires higher magnetic power than some other ores. The magnetic separation is, however, not

complete, and there is still room for considerable improvement in the treatment of Cornish ores. Some discussion has recently taken place regarding the genesis of magnetic separation in Cornwall. The credit for its introduction, according to the Cornish correspondent of a leading mining journal, is due to Professor Bauerman and Mr. W. Thomas. However that may be, metallic tungsten is used for hardening special steels, and recently a new incandescent lamp has been placed on the market, the filament of which is made of metallic tungsten. This lamp gives a brilliant white light. Tungsten salts are extensively used in silk manufacture, and sodium tungstate is used for fire-proofing curtains, &c. Moissan has shown that it is an easy matter to prepare crude tungsten in the electric furnace, and that this might be refined by remelting the metal in presence of an excess of tungstic acid.

JAPANESE CALICOES.

Calico printing by machinery in Japan is a comparatively new industry, the first works with modern improvements having been established about twelve years ago. A few years later a new company was formed with a capital of £50,000, with mills for spinning, weaving and printing. In 1901 another company was added, with addition to the capital stock from time to time until it reached £180,000 at the beginning of 1907. These are now the largest and best works in Japan. According to the American Consul at Kobe, this company has paid a dividend of 30 per cent. per annum for the past three years, the balance of all profits being carried forward for improvements. The land owned by the company is over twelve acres in extent, and the buildings cover nearly four acres. Early this year it was decided to erect a new factory, containing twelve machines exclusively for calico printing. The factory will be separate from the old one, but under the same name, with a combined capital of £500,000. The total number of machines in Japan will probably not exceed twenty-four, half of which are of Japanese make. Most of them are engaged in printing cotton flannel. The annual output is between 1,500,000 and 2,000,000 pieces of 30 yards each. About one-tenth is exported to China and the remainder, mostly flannel, is used at home. The total exports of all kinds of cotton prints amount in value to about £120,000 a year. The large calico flower-patterns, which are hard prints, are a much desired article in China, and even in the United States. This cloth, locally known as cotton crêpe, is of the poorest quality, but it always finds a ready market on account of its remarkably low price. Concerning the highly-finished, or best quality printed calico, it is safe to say that Japan is not yet in a position to compete with American or European manufacturers. The average pay of a Japanese operative is about 7½d. per day, while a skilled workman will receive about 1s. 3d.

ARTS AND CRAFTS.

Modern Metal Work.—So much amateurish metal work is to be seen in London at this time of year that those who really care about art and workmanship are sometimes tempted to ask, what is the good of it all? Is it so very much better to be amateur than to be trady? Has the Arts and Crafts movement done nothing but create a new set of shibboleths in place of the old ones? There is a kind of work, unfortunately not so uncommon as one could wish, which makes the lover of good workmanship sigh for objects, no matter how commonplace, which are decently made. There is a kind of perverse ingenuity in design which arouses a positive longing for something which has been done before and has no claim to rather ugly originality. And it cannot be denied that this kind of stuff (there is really no other word which quite describes it) is the direct outcome of the Arts and Crafts movement. Nevertheless, it is only the superficial or the biased observer who would stop short at this point in his estimate of what the movement has done. It is, in fact, just in this craft of silversmithing, grievously as it has suffered from the hands of certain amateurs and would-be craftsmen, that some of the very best results of the entrance of the artist-craftsman into paths at one time regarded as reserved to the trade worker are to be seen. In days gone by it was the rule, when a large piece of presentation plate was wanted to go to a shop (indeed there was nowhere else to go) and let them get it made, with the result that the cup, or casket, or whatever it might be, was as often as not as far removed from art as anything could well be. Now, those who really want fine plate have their choice amongst a number of artists and craftsmen to whom they can turn for designs. The names of Mr. Fisher, Mr. Dawson, and Miss Steele, are known to most people, and there are other artists doing good work. Further, the manufacturing firms seeing that artistic work is more or less in demand, are far more ready than they were, both to engage trained designers and to go to them for help when it is a question of securing some important order.

Four Loving Cups and other Silversmiths' Work.—There have been several little exhibitions of silver-work this month, but the one which, if only from the importance of the things exhibited, comes first, is that of Messrs. Omar Ramsden and Alwyn C. E. Carr. The works to be seen in their studio included not only the monstrance for the Westminster Cathedral, which was more or less privately on view by itself for a short time in the summer (and which now could be seen, perhaps, to better advantage, surrounded by other works of art), but also no fewer than four handsome loving cups with covers. These are—the cup to be presented by the University of London to the University of Paris, that to be given to the Worshipful Company of Cloth-

workers by Sir William Bousfield, the one recently presented to the Honourable Society of the Inner Temple by His Honour Judge Lumley Smith, and another subscribed for by a group of well-known authors for presentation to one of their body. These four works are all of them excellent in their way, but the first two are the larger and more important of the group. We are hearing so much just now of the *entente cordiale* and the Franco-British Exhibition that this, so to speak, Anglo-French cup calls in a sense for special attention. Both its design and workmanship, however, quite apart from feelings of momentary sentiment, compel our serious consideration. The idea of the makers was that a cup to be presented by this country to France should be characteristically English in design and should, at the same time, give evidence of having been specially schemed for its purpose. They have, therefore, sought their inspiration (though by no means the lines of their design) in the traditions of English Gothic—and they have produced something which is a triumph of English silversmiths' work. From the dainty symbolical figure holding aloft the "Torch of Knowledge," on the top of the cover, to the massive bosses of metal at the foot of the cup, the work is well-considered and harmonious. The corona of "English" roses encircling the cover is particularly happy, and the arms of the two universities and the shields of the people of England and France are very judiciously introduced. In Sir William Bousfield's cup the corona is of teazels (which form a part of the Clothworkers' arms), while the knot of the cup consists of three admirably vigorous eagles borrowed from the donor's crest. The arms of the various colleges which ornament the bowl make very satisfactory decoration.

The number of less important objects such as rose-bowls, tea-sets, mustard pots, and toilet articles exhibited at the same time prove not only that such things can be made really beautiful, but that they are obtainable at a price which anyone who wants a good thing ought to be quite ready to pay. It is evident that there is nowadays no valid excuse for having ugly silver things. Good ones are to be had if only the buyers will use their eyes and their wits instead of rushing incontinently into the first shop they come to.

Mr. Harold Stabler showed some interesting metal-work early in this month including, amongst other things candlesticks, tea caddies, &c., in pewter. Those who can afford silver often complain of something rather unpleasant in the quality of this metal, but for those who cannot, find it entirely to their liking. Mr. Stabler has produced some severely simple pieces of work which are not only interesting but beautiful.

Pottery.—In a trade like pottery-making there cannot, of course, be startling novelties every few months. The experiments necessary in order to produce different kinds of glazes or other changes in the manufacture take time. But, for all that, a very short space of time reveals the fact that potters in this country are not content to stand still, but are slowly and steadily forging ahead—and that, moreover, unlike some of their contemporaries on the continent, they are not aiming merely at producing now and again a few pieces which will do them credit at exhibitions, but at creating a real market for the kind of ware which necessitates constant experiment and accurate scientific knowledge.

The Lancastrian lustre ware seems now to have made a place for itself in London. Not only was it on view at a recent exhibition at the Baillie Gallery, but it is to be seen at Osler's and also at Morris's, where it has stepped into the place left vacant by the closing of Mr. de Morgan's works. The patterns are still painted freely on to the pieces, mainly by the artists responsible for their design, and they show for the most part a real sense of fitness and of scale. One is surprised, however, now and again to find figures and ornament which do not seem to correspond. A few examples of lustre on delicate matt "fruit skin" glazes have been shown, and the quality both of colour and iridescence produced in this way is as pleasing as it is remarkable. Another eminently satisfactory method of procedure is to glaze a bowl so that the inner surface is enriched with light lustre delicately painted whilst the outside is entirely coated with a strong rich red. Here and there, pieces are to be found which prove that, perfectly as the potter has his material under control, and possible as he finds it to get over and over again effects which are all but the same, the fire will occasionally do what is not expected of it and produce pots which must quite obviously be unique. And this fact is not among the least of the claims of pottery of this kind. That every fine piece should be the result of a happy fluke is eminently undesirable—that a happy chance should occasionally be responsible for an unique and unusual specimen, adds interest both to the production and to the collection of the ware.

Mr. Bernard Moore's ware has also been lately exhibited in London. This is glazed almost exclusively in different sorts of red—*sang de bœuf*, *rouge flambé*, and gold *flambé* are all represented. The colour of the *rouge flambé* is gorgeously rich—and when used in smallish pieces very attractive. It is seen at its best when so employed that those parts of the vase where the glaze would naturally lie most thickly show a very dark crystalline effect. The colour of a few other pieces which look as though they had been slightly smoked is remarkably fine in quality. The gold *flambé* which displays the delicate pinkish shades of red which only gold can give, is also beautiful in colour. The so-called Hispano-Moresque ware is less satisfactory. Its colour, though not unpleasing, is hardly what one naturally associates with the name, and the painting seems a trifle coarse for the quality of the pottery.

OBITUARY.

William Arnold Hepburn.—Mr. Hepburn, Clerk to the Leathersellers' Company and member of the Society of Arts since 1889, died suddenly at Hampstead on Saturday morning, 14th inst. He was born in December, 1848, the son of Mr. J. G. Hepburn, solicitor. He was educated at King's College School and admitted a solicitor in 1874, taking high honours in the qualifying examination. He became a member of his father's firm, but relinquished his partnership on election to the post of Clerk of the Leathersellers' Company in 1884. Mr. Hepburn was much interested in the work of the Society of Arts' Committee on Leather for Bookbinding, towards the publication of the illustrated edition of whose report his company liberally contributed a sum of £250. His father took the chair in 1876 at a meeting of the Chemical Section of the Society when a paper on "Sole-Leather Tanning" was read.

GENERAL NOTES.

International Drawing Congress, 1908.—The arrangements are being made for the third International Congress for the Development of Drawing and Art Teaching, to be held in London from August 3rd to August 8th next, 1908. Foreign secretaries have been appointed for Austria, Belgium, Bulgaria, France, Germany, Holland, Italy, Luxembourg, Switzerland, and the United States, in which countries exhibits for the Congress are being organised. The branch of the Congress dealing with the application of arts to industries will be very representative and has already aroused the interest of many large manufacturers. The Lord Mayor of London will preside at a meeting at the Mansion-house on the 12th February next, when several authorities will speak on the aims and objects of the Congress and the importance of its work.

Cocoa Exports from Ecuador.—The extent of this export from Ecuador is not, perhaps, generally recognised. In his report just issued (Cd. 3727-29) Mr. Consul Cartwright says that the record crop of cocoa so far has been that of 1904, when the quantity available for export was 562,810 quintals, or say 25,000 tons. The following year gave 459,293 quintals, or a little less than 21,000 tons. This short produce was, however, more than compensated for by the regular and rapid increase in value. The average price of cocoa in 1905 was 30 sucres, or about £3 per 50 kilos f.o.b. Guayaguil. In 1906 this had been increased to an average of 34 sucres or £3 8s., and now in 1907, a still further increase of nearly 40 per cent. has taken place, the average price for the year being 47 sucres, or £4 14s. per 50 kilos. This has been of great benefit to the agricultural and commercial interests of Ecuador, and has largely increased the value of its exports. The Government duties are not *ad valorem* but per weight exported, so that the financial position of the executive has not improved in the same proportion as prices have appreciated.

Austrian State Revenues.—In the course of his report on the finances of Austria-Hungary for the years 1905-7 (Cd. 3727-30), the Hon. L. D. Carnegie, Chancellor of His Majesty's Embassy at Vienna, explains that the State revenues are first paid into district offices, whence the money is drafted into the head office of the province. Each provincial office keeps a working cash balance in hand. The moneys in the provincial offices are collected by the Postal Savings Bank office, of which the Postal Savings Bank, as understood in the United Kingdom, forms only a small department. The money received by the revenue earning departments, such as the Ministry for Railways, is used for the necessary current expenditure; any surplus over at the end of the month is transmitted to headquarters through the Postspar-kasse. The Austro-Hungarian State Bank receives the gold and main bulk of the revenues, but the Postal Savings Bank performs the general duties of tax collector and paymaster-general. The sums lying in the various State offices throughout the country, together with the money on deposit at the State Bank and in the Postspar-kasse make up the Treasury balance. The tendency of the financial administration is increasingly to place the Postspar-kasse in the position of banker to the State.

MEETINGS OF THE SOCIETY.

Juvenile Lectures.

F. Martin Duncan, "The Scientific Applications of the Cinematograph." Two Lectures.

Lecture I.—January 1.—The Cinematograph as a popular instructor—A note on persistence of vision—How the spinning of a shilling was responsible for the invention of Cinematography—Early workers in the field — Muybridge — Marey — Anschutz — The Thaumatrope—Wheel of Life—Zoetrope—Choreutoscope—Book form apparatus—The modern Cinematograph really the result of the invention of Celluloid—The application of the Cinematograph to Microscopy.

Lecture II. — January 8. — The Scientific Applications of the Cinematograph—Its application to the study of Insect Life—To Animal Life—To Plant Life—To the study of the races of mankind—The future of the Cinematograph.

Each Lecture will be profusely illustrated by ordinary lantern slides, slides by the Autochrome Natural Colour Photography, and by Animated Pictures.

Journal of the Society of Arts.

No. 2,875. VOL. LVI.

FRIDAY, DECEMBER 27, 1907.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 1, 5 p.m. (Juvenile Lecture.) F. MARTIN DUNCAN, "The Scientific Applications of the Cinematograph." (Lecture I.)

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience, will be delivered on Wednesday afternoons, January 1st and 8th, at 5 o'clock, by F. MARTIN DUNCAN, on "The Scientific Applications of the Cinematograph."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who desire tickets for the course are requested to apply for them at once.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE THEORY OF THE MICROSCOPE.

By CONRAD BECK, F.R.M.S.

Lecture I.—Delivered November 22, 1907.

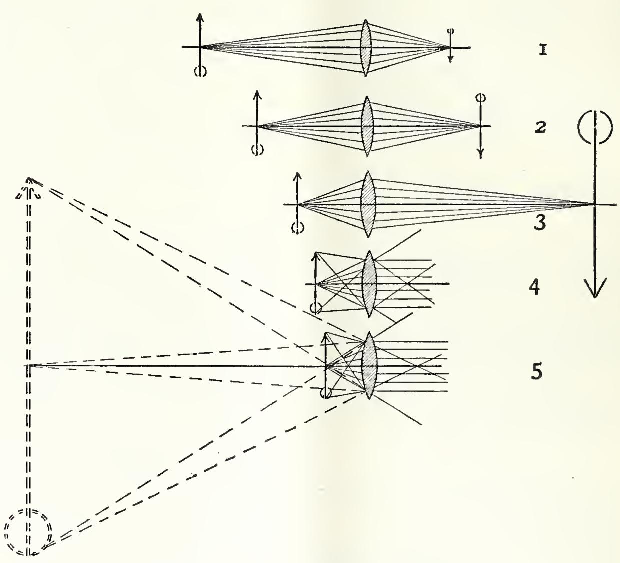
THE OPTICAL CONSTRUCTION OF THE INSTRUMENT.

Syllabus.—Scope of the lectures—Image formation with a single lens—Laws of conjugate images—Three forms of simple microscopes—Their relative advantages—Magnifying power of a simple microscope—Three inherent defects of all simple microscopes—Investigation by means of the Gauss system of their cure, showing working distance increased, high magnifying power, and larger field of view obtained with the compound microscope, consisting of object-glass and eyepiece—Positive *versus* negative eyepieces—The Ramsden circle magnifying power of compound microscope, tube length, and correct method of expressing magnifying power.

In the years 1885 and 1888 series of excellent lectures were delivered in this room by John Mayall, jun., on the history of the microscope. They dealt exhaustively with the historical development of the instrument from the time of the Assyrians. They described the mechanical construction in great detail, but the optical qualities were of necessity treated on somewhat vague lines. In the early records of these instruments their optical properties were but imperfectly expressed. The inventors of the first microscopes did not understand much of optics, although by means of experimental trials they produced instruments by no means to be despised. As one might expect, the results of such trials, some failures, some successes, leave no complete record of the development of the theory of the microscope. History

frequently helps one to more thoroughly master the intricacy of a complex subject, but in this case, even if it existed, it would not be illuminating, because the development did not proceed along scientific or continuous lines. The modern microscope is optically the most elaborate and the most interesting of all optical instruments, and although for the reasons just mentioned it cannot be explained on historical lines, we shall commence as if such a system had been possible, with a consideration of the simplest possible form of the instrument, noting its defects and limitations, and the manner in which these have been overcome. By proceeding will be formed upon the screen. If the object is shifted in position the picture on the screen will disappear, and the screen must also be shifted to some other position before a sharp picture of the object is formed; for each position of the object there will be one position for the image only, but for every position in which the object is placed there will be a corresponding position where an image is formed. Any two positions of the object and its image are called conjugate planes or conjugate focal planes. The investigation of the images or pictures formed in these conjugate planes constitutes the basis of the theory of most optical instruments.

Fig. 1.

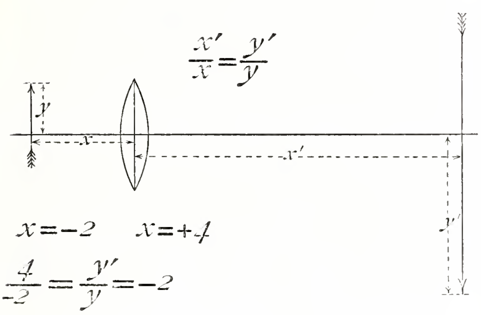


on this principle the particular part played by every portion of the modern instrument will be understood, and what appears at first sight to be a complex piece of apparatus will be classified into a few groups of lenses, each having special characteristics. Instead, therefore, of plunging at once into the explanation of the compound microscope, let us examine the properties of a simple double convex lens. It is needless to explain that a positive lens can produce an image; nevertheless, it will, perhaps, be a pleasure to you, as it always is to me, to observe again this picture-making property, illustrated by the simplest of all experiments. If a brilliant object be placed upon one side of a positive lens and a white screen upon the other, by moving the screen from place to place a position can be found at which a picture of the bright object

When the object, as in Fig. 1, is placed at a considerable distance its picture is close to the lens and is small. As the object is approached to the lens, as in Fig. 1 (2), its image is further away and is enlarged until when the object is brought still closer, as in Fig. 1 (3), the image is still further away and is magnified several times. As the object is approached still nearer to the lens its image is produced further away until a point is reached at which the image is formed at an infinite distance. What then occurs when the object is brought still nearer to the lens? its image cannot be formed at a greater distance than infinity. Mathematicians say that infinity has no limits, that eternity has no beginning, they discuss a fourth dimension and other problems that bewilder the mind of the mere man and certainly they have some justification.

For if the image formed by a lens be carefully watched as the object approaches the lens, it is seen gradually to move further away till at a certain position of the object it reaches infinity, after which for a further movement of the object it leaps instantaneously from infinite distance on the one side of the lens, to infinite distance on the other, and steadily comes back to the lens from the opposite direction, as shown at Fig. 1 (5), but with a difference. Having once been to infinity it returns as a ghost. It no longer actually exists in space, it cannot be demonstrated by means of a screen, but the light emerging from the lens behaves exactly as if this ghostly image really exists, and an eye placed in the line of sight cannot tell from observation that this so-called virtual image is not a real object. When the image leapt from infinity on one side of the lens to infinity on the other, a further change took

FIG. 2.



place during the process, it was turned upside down, for whereas it had previously been an inverted picture of the object, it now becomes erect. Two useful laws of image formation are here demonstrated, Laws which in fact govern many of the simple problems connected with optical instruments.

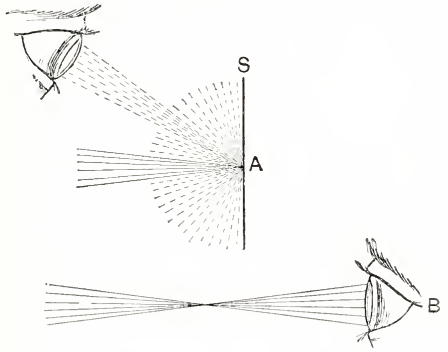
1. If the image is on the opposite side of the lens to the object it will be the opposite way up or inverted. If the image is on the same side of the lens as the object it will be the same way up or erect.

2. The size of an object compared with the size of its image will be in exact proportion to the distance of the object from the lens compared with the distance of its image.

These two laws are expressed by the equation $\frac{x'}{x} = \frac{y'}{y}$ where x and x' are the distance of the object and image, and y and y' are the heights of the object and image above the axis. Signs being reckoned on ordinary geometric principles. If x is on the left of the lens and x' on the right, x will be minus in sign x' will be plus, therefore, if y is plus y' will be minus and the image will be inverted. The relative sizes of an object and its image being equal to their mutual distances is given by the same formula and the simplicity of the expresssion $\left(\frac{x'}{x} = \frac{y'}{y}\right)$ renders it a useful note to stow away in one's memory.

A microscope is an instrument which forms an enlarged picture of a small object, and an examination of the figure of conjugate images, Fig. 1, shows three distinct methods of making a microscope with a single positive lens. If a screen be placed where the image is formed in Fig. 1 (3) the enlarged picture will be seen upon it. If the screen be removed, and the eye be placed some distance behind in the course of the rays, the image can be seen direct existing where the screen previously

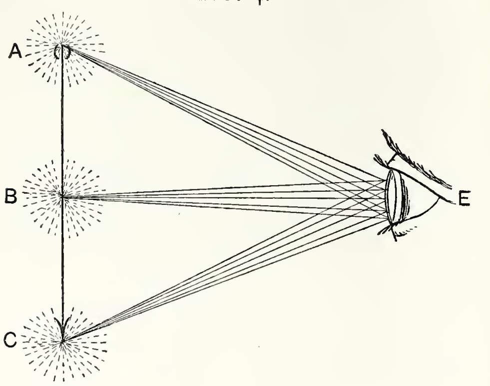
FIG. 3.



stood, or if the eye be placed close to the lens as in Fig. 1 (5) an enlarged erect image is seen. If the object be situated as at Fig. 3, with a white screen placed where the image is formed, a projection microscope is created. A well-known example of this is the magic lantern. The distinguished name of microscope is not applied to a lantern, because it is not generally used to investigate objects so small that they cannot be seen with the naked eye, but merely to render a diagram or picture that can be readily observed by a single observer large enough to be seen by a number. This first method of making a microscope has its good points, it will give any degree of magnifying power provided that sufficient space is available, and more than one observer can see the picture, the image has only to be projected farther away to increase its size, but it suffers from the practical disadvantage that the object must be illuminated with an intensely brilliant light. The diagram (Fig 3) A indicates a screen, S receiving the pic-

ture of a point of light focussed upon it by means of a lantern. The effect of the screen is to distribute the light thus received in all directions so that the quantity conveyed to it in a solid cone of, say, one degree is

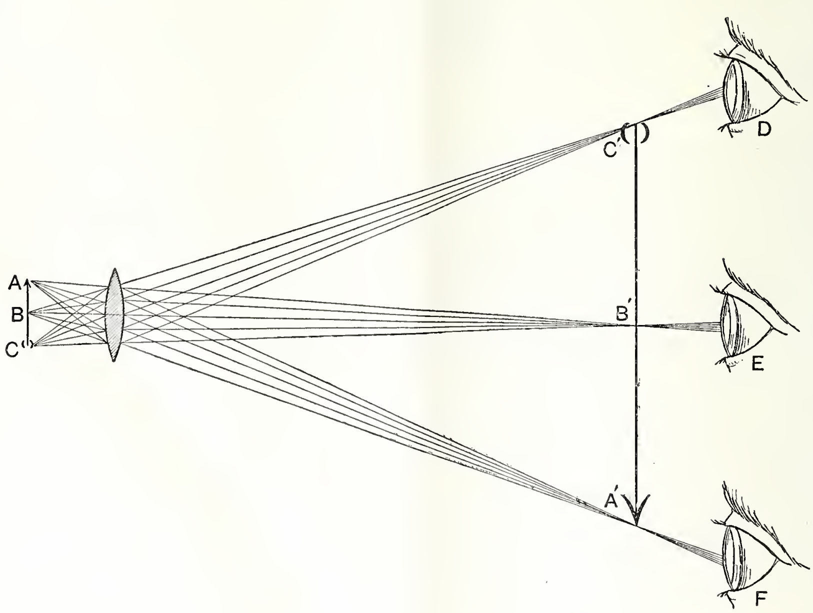
FIG. 4.



reflected in a solid cone of 180°, and the light which can be collected by the eye of a single observer is perhaps not more than 1-100000th of the total quantity. This form of microscope is therefore unsuitable for giving high magnifying power.

whether the screen be there or not, it is formed by the lens and not by the screen. It may be examined as if an enlarged copy of the object actually stood where the screen was placed, but with this difference. If an actual object A B C (Fig. 4) is examined every point on that object is reflecting light in all directions, and an eye placed at E can collect a pupil full of light from every point on the object and thus see the whole area at once; whereas if an image A′ B′ C′ (Fig. 5) is being formed by certain definite rays, an eye placed at E can only see the centre of the picture, and must be moved to D to see one end or to F to see the other extremity. Thus this second form of instrument has only a small field of view, so small a portion of the picture is seen at one time, that although in combination it forms the basis of the present compound microscope, it was never developed as a simple instrument. Even now this useful means of obtaining a high magnification with a pocket lens is seldom realised. The difficulty in its use consists in the fact that the lens must be placed a long way from the eye. Nothing can be seen by the unassisted eye, unless it is placed at a certain distance away one cannot

FIG. 5.



The difficulty of insufficient light may be overcome if the second method be used and the screen be removed, as shown at B, and if the eye be placed in the direct line of the incident light. The image exists in space,

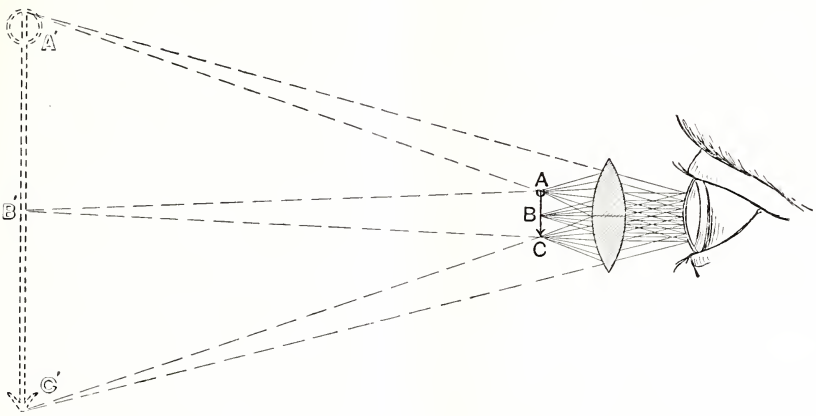
see one's eyelashes. and although a very young child may be able to examine an object three or four inches off, an ordinary observer must place his eye at about 10 inches behind the position A′ B′ C′ where the image is formed.

A pocket lens held at arm's-length can be made to give two or three times its normal magnifying power on this principle, but its field of view is very small.

The third form of microscopes (Fig. 6), is the ordinary magnifying glass where the object is placed sufficiently close to produce a virtual or ghost image some way in front of the eye; it also requires the eye to be placed in the line of sight, but it largely overcomes the defect of the limited field of view, for provided the eye be placed sufficiently close to the lens it can gather in quite a large proportion of the light from the virtual image A′ B′ C′, and can see the whole of the object. It also gives an erect instead of an inverted picture.

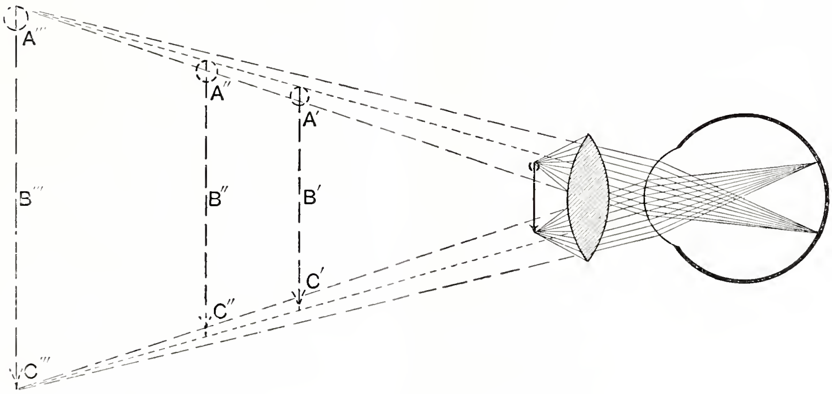
This type of microscope has an important characteristic. It gives only one magnification. In the two previous forms a different degree of magnification could be produced by altering the position of object and lens. Here one lens gives one magnification. If the diagram (Fig. 7) be referred to, it will be objected that by slightly altering the position of our object we can produce its image at different distances, either at A′ C′ or at A″ C″, and that as this image is further from or nearer to the lens, so it is larger or smaller.

FIG. 6.



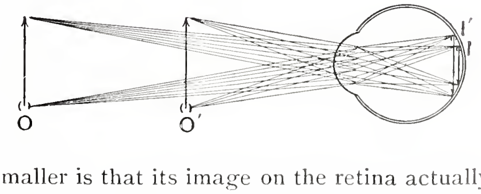
That is so; but it must be remembered that as this image goes away from the lens, so also it goes further from the eye, and though in reality it is larger, yet, being further away, it appears smaller, and no alteration in its size is visible.

FIG. 7.



The diagram (Fig. 8) will recall the fact that the reason why an object at a distance looks smaller is that its image on the retina actually is smaller. The eye is a form of camera; an

FIG. 8.



object at O, which is seen at I on the retina, will be seen twice as large; if it be brought to O, twice as near; and thus the reason that a distant object looks small is not a mental association, but a solid fact.

The position at which the virtual image seen through a lens actually does exist is at present undetermined, and probably differs with different individuals, but the image in the eye is always the same size if it subtends the same angle.

Fig. 9.

1	2	3	4	5	6	7	8	9	10	11	12
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

The question of magnifying power may now be investigated. The first point to be clearly borne in mind is that with the microscope magnifying power is always expressed in linear diameter. It may be true that a carpet 12 feet square will cover 144 tiles which are one foot square, yet it has only a linear size or length 12 times that of the tile. A room which is 12 feet square and 12 feet high will contain 1,728 boxes one foot square; it has only a linear size 12 times that of the box. The magnifying power of a microscope is denoted by linear diameter by the relative lengths of object and image, and not by their relative areas or cubic capacities.

Magnifying power is not so easy to express as might appear at first glance. If an actual image of an object is formed on a screen as in the case of the first described methods of making a microscope, no difficulty presents itself; the diameter of the object can be measured in inches or millimetres; the diameter of the image can also be measured and their relative size can be ascertained. But where no actual image exists, where it is only a virtual image that cannot be got at in order to measure it, the question is not so simple. It can be calculated, but to do this we must either consider it as subtending an angle or we must assume that the image is at a certain distance from the eye. A difficulty arises in conveying a correct idea of the size of any object which is inaccessible. It is sometimes said that the moon looks the size of a plate, a Dutch cheese, or a piece of chalk. None of these give an adequate idea of its apparent size. It will be found that a good-sized pea, held at arm's length, will obliterate it, and it is evident that in order to explain the apparent size of a virtual image that cannot be actually measured, it is necessary to suppose that such virtual image exists at some definite position. It means nothing to say that the image of some object when seen through a simple microscope is 3 inches diameter; 3 inches at a distance of 100 yards will appear as a point, whereas 3 inches at arm's length would be a perceptible size; neither is it any good to say that it looks ten times the length of the original object, because the original object looks different sizes at different distances from the eye. It is necessary to say it looks ten times the size that the original object appears when that is placed at some definite distance from the eye. The only important thing is that the same distance should always be used. It makes no difference what distance is selected for the purpose. It is fortunate that the distance which was originally selected has been universally adopted, and is not likely to be changed. The near point of vision is somewhere between 8 and 12 inches, and with this consideration in view the distance of 10 inches from the eye has been selected as the position at which it is assumed that the virtual image formed by a mciroscope, exists.

Now what does it mean when we say that a simple microscope magnifies five diameters? It indicates that if an object one inch in diameter will appear a certain size to the naked eye when placed at a distance of ten inches, the microscope will make it appear as if it were an object five inches in diameter placed at ten inches from the eye. It is important to understand how this affects the question of magnifying power.

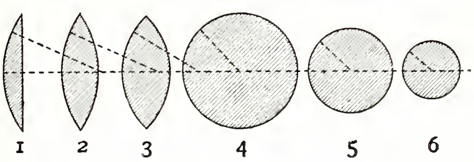
Suppose a diagram of fine lines is being examined, and it is found that a series of lines 100 to the inch can be readily seen when they are placed 10 inches from the eye, a microscope magnifying five, produces a picture in the eye, five times the size of that produced by the diagram when held at 10 inches, and consequently lines 500 to the inch are visible. That is, a magnifying power of five, allows five times the amount of detail to be observed to that which is seen when one

examines objects at a distance of 10 inches. Many observers, however, and especially those who are short-sighted, are in the habit of examining minute objects much closer to the eye, and bringing the object much closer to the eye will mean that a larger picture is formed on the retina. Some very short-sighted people can place an object as close as two inches from the eye and thus see five times as much as at 10 inches; consequently they can see 500 lines to the inch. It would appear to such an observer the microscope magnifying five times would show nothing more than they could see with the unaided eye. As a matter of fact, such an observer would obtain some magnification, but it would be considerably less than that gained by the normal eye. Nevertheless, the microscope is said to magnify five times, because it is considered that objects are generally examined at 10 inches distance, and the picture formed will be five times the size of its original if placed 10 inches. For this reason disappointment is sometimes experienced at what appears to be the small magnifying power of a pocket lens.

The simple microscope in the form of a pocket lens has the defects of a single uncorrected lens; it has spherical aberration, chromatic aberration, distortion, and a curved field. These defects can be cured, as will be seen in our next lecture. It can be made to give good defining power. It has a fairly large field with moderate magnification. Its magnification depends on the focal length of the lens and that only. Why not make the focal length of such a lens as short as is required and get any magnifying power that may be desired?

The answer is that a simple microscope has certain incurable defects which render such a method impracticable for high magnification. First, the object to be examined has to be placed too close to the lens. It must be remembered that owing to the fact that the various aberrations must be corrected a thin lens cannot be used, a corrected lens generally works out as at least three and sometimes four or five lenses combined, and in some forms the object to be examined would require to be within only a few millionths of an inch from the front portion of the combination in order to be seen. Secondly, lenses would have to be made microscopically small. A single lens with a magnifying power of about 1,000 could not be made of larger diameter than 1-50th of an inch. The reason of this is obvious. The focal power of a lens depends on the radius of the curve to which it is ground. Fig. 10 shows at 1 a plano lens of moderate power. By making it double convex, putting the curve on both sides as at 2, we double the power; by increasing the curvature at 3 we still further increase the power, till eventually it becomes a sphere, as 4. Here we can only further increase the power by making the sphere smaller, as 5 and 6. No curved lens can be made larger that a sphere, and therefore, if a lens has a radius of 1-100th of an inch, it cannot by any means be made larger than 1-50th of an inch. A small lens used as a pocket magnifier can transmit, but a small bundle of light and the pupil of the eye,

Fig. 10.



instead of being filled with light, receives only a minute fraction of the amount required to give a brilliant image. Thirdly, the eye cannot be placed with comfort nearer than about half-an-inch from the lens on account of eyelashes and eyelids, and although this may not matter with a low-power lens, such as 2 (Fig. 11) with a high power, it seriously restricts the field on view. The diagram (1), Fig. 11, shows that the higher the power of a lens producing a highly magnified image, the nearer the eye must be in order to see more than the centre of the object. The light with a high power is emerging at a greater angle in order that a larger picture may be produced in the retina.

This is rendered still worse by the fact that thick combinations of lenses must be used to correct the aberrations which renders it still more difficult to place the eye near to the projection centre of the system. Thus a limit of usefulness is reached for the simple microscope. It is serviceable for magnifying powers up to about 15 to 20 diameters, and if no compound microscopes were available it might be used for somewhat higher magnifications, but it would only be with difficulty.

Thus the three radical defects of a high-power simple microscope are:—

1. The closeness of the object to the lens.

2. The impossibility of getting magnifying power except with minute lenses.

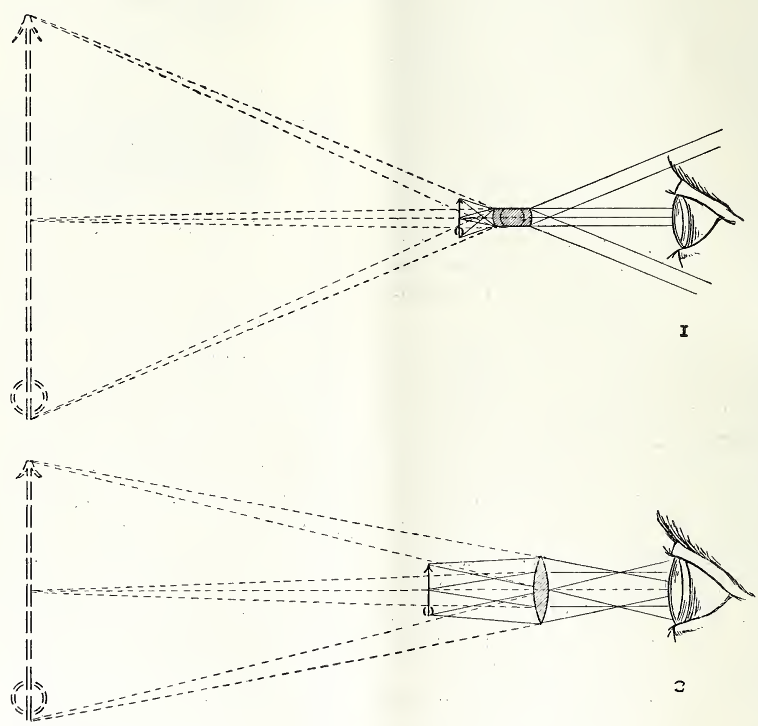
3. The restricted field of view.

In order to investigate the methods by

which these defects have been overcome, it will facilitate matters if a few minutes are spent in considering the noted method of the German mathematician Gauss for dealing with combinations of lenses. It will be seen in the course of these lectures that the production of the compound microscope has been due to complex combination of lenses both to correct the defects of a simple lens already mentioned, and also to correct the various aberrations.

tion of images formed by compound instruments are difficult to ascertain if every individual lens has to be treated as a separate item. But Gauss has shown that, under certain conditions, any complex system of lenses may be replaced by a single so-called equivalent lens, and that the effect produced by this compound system may be studied by supposing it to be for the time being a single equivalent lens. The idea will suggest itself, that if this is so, why use compound systems at all; why not employ

Fig. 11.

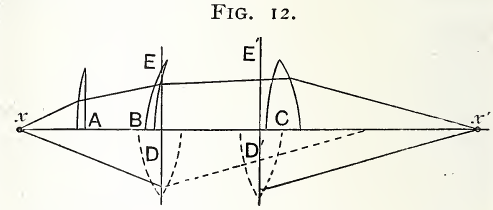


By the use of Gauss's elegant device the action of a complicated combination of lenses can be grasped with almost the same ease as that of simple lens.

The substance of this theory may be explained as follows. Suppose A, B, and C (Fig. 12), represent a set of lenses forming a compound optical instrument. In the upper half of the diagram is shown the course of a ray of light emerging from a point X, which is refracted or bent at each lens, and finally arrives at the point X′. To trace the course of such a ray through the 12 or 14 lenses which sometimes compose a microscope would be a tedious and difficult operation, and, what is worse, the performance of the microscope as a whole would be almost impossible to comprehend. The size and posi-

the equivalent lens instead. Well, for this reason, that the equivalent lens, in order to personate a numerous set of lenses, must be endowed with the pecular quality of being in two places at once. No single

Fig. 12.



lens placed in one position will do the work. It must have the power of being in one position, E, to receive the light, and in the second position, E′, to discharge it. In practice a dual personality cannot be bestowed

upon a lens, but for investigation it is quite an easy matter to imagine such a rapid shift in its position.

The system of three lenses, A, B, and C, in the diagram may be represented by a so-called equivalent lens, D, which exists at the first equivalent plane, E, for receiving rays, and at the second equivalent plane, E′, to discharge them. The equivalent lens has a particular focal length or power according to the system it is to represent, and that is called the equivalent focus, and it is indeed the true focal length of the compound system. It will then for many purposes be possible to forget the complicated system and work out the problems of image formation, just as would be done with a plain lens and with just the same simplicity except for this shifting of its position from one equivalent plane to the other. In the diagram the equivalent lens, D, must be considered as existing at E, to receive the light from x, and as existing at E′ to discharge the light to x'. It is thus possibly to rapidly comprehend the action of a complicated instrument.

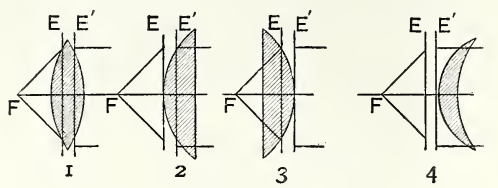
All measurements with reference to light entering the system must be made from E; all measurements with reference to light emerging from the system, must be made from E′, and the numerous refractions which take place at the various lenses, may be considered as being represented by two single refractions, one at E, and the other at E′. Every combination, however complex, provided it has a focus at all, has an equivalent lens, and two equivalent planes, and the equivalent focal length and the position of the equivalent planes having been found, the whole may be dealt with, and investigated.

The positions of these two equivalent planes, which vary in a most surprising manner according to the construction of the lenses, forms the key to the action of the instrument. This elegant theory has, however, limitations which must be understood. It can only be applied to lenses as regards their central portions. The edge of a large lens, as will be seen later, does not act in the same manner as its centre, neither do the rays of light that pass obliquely through a lens behave in the same manner as those which pass through it direct. The Gauss theory is only true for central direct beams of light. The microscope deals with very wide angle beams of light, and beams far from its central axis, as well as the central direct ray, so that it would appear that the Gauss theory can be of but little practical service for investigating microscopal problems. But the endeavour of the optician in manufacturing the instrument is to so arrange and correct his lenses that their edges, taken in combination, will act upon the light in exactly the same manner as their central portions, and so that they will act upon the oblique in a similar manner to the direct rays. This he actually accomplishes to a large extent, and thus, although the Gauss theory cannot be strictly applied, to the individual uncorrected portions of the instrument; as soon as the corrections have been made, the compound system can be considered as a perfect Gauss system. The optician cannot employ the method in making his various corrections, but. once the instrument is formed, the problem of magnifying power, illumination, and other questions effecting its general behaviour can be investigated by this means. There are certain conditions of the Gauss theory which cannot be fulfilled quite accurately, and to this extent results obtained with the simple method may require correction which fortunately will be small with a well-corrected system.

If the method of investigation be now applied to the consideration of the simple microscope, the methods by which its disadvantages can be removed may be studied. The magnifying power of a single lens, or of a system of lenses, is of course expressed by its focal length. The focus or burning point is the position where the rays of sun shining through it meet in a point the position where an image of an infinitely distant object is formed; and an equivalent focal length is the distance from the focus to the equivalent plane belonging to that side of the optical system. We know that the focal length of a system can be shortened, and the power thus increased by altering the curvature of the lenses, but as has been shown this involves practical disadvantages, one of which is that the object has to be placed very close to the lenses, but what Gauss showed was that the position of the equivalent planes could be altered to an almost unlimited extent by altering the shapes and positions of the lenses without affecting the power of the instrument, and thus that the position of the focus of a system can be altered without altering focal length or the power of a lens. The equivalent plane, together with the focus, can be pushed forwards or backwards. This can even be done with a single lens to a small extent, as shown in Fig. 13. The focal lengths of these lenses are all the same, but owing to

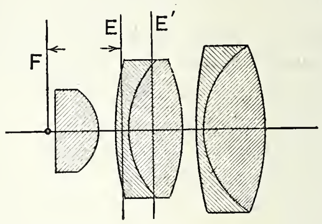
a difference in shape the equivalent planes E E′ are in different places, and thus to examine an object placed in the focus, F, using such lenses as simple microscopes, lens 4 need not be placed as near to the object as lens No. 3, and a gain in working distance is obtained. It will be well next to examine where these equivalent planes lay in a high-power microscope object-glasses. For reasons that will subsequently appear, such an object-glass must be made of a number of lenses close together, and although the types made by different makers vary, and in consequence the positions of their equivalent planes vary also. The next diagram (Fig. 14) may be taken as an example of a common type. The focal point where the object must be placed, if the lens system is to be used as a simple microscope, is practically on the surface of the front lens, and it will thus be seen that as

Fig. 13.



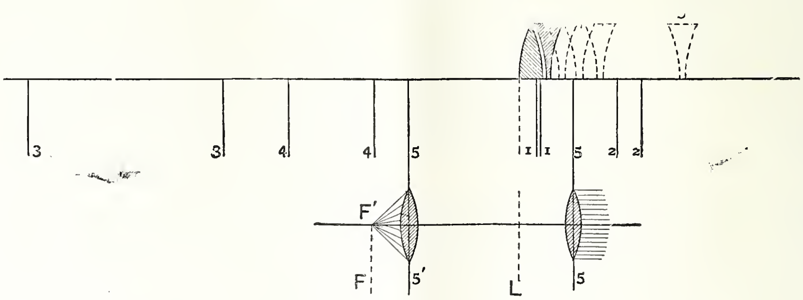
investigated, but the lantern slide exhibited will indicate the astonishing way in which the positions of the equivalent planes of a lens system are altered when two lenses are separated. The numerals in Fig. 15 represent the positions of the equivalent planes corresponding to the different positions of the negative lens, the positive lens remaining stationary.

Fig. 14.



Attention may now be confined to the final position in the diagram 5, 5, where the lenses are separated by the greatest interval, the action of the complete system will be as if an equivalent lens of the focus 5′, F′, were placed first at 5′ to receive the light, and then at 5 to discharge it into an observer's eye. Thus it will be seen that the complete system has the magnifying power of a single lens placed at 5, but the object can be placed at the great

Fig. 15.



a means of curing the defect of closeness to the object which we have seen to be inherent in the simple microscope, a series of lenses close together will not be of such assistance. Therefore it will be well to consider what happens to the position of equivalent planes when lenses are separated. The results of such an investigation are very remarkable. I do not propose at this time to go into the question in detail. In a paper read at the Optical Convention of 1905* the matter was

distance, L, F′, away from the actual optical system, and the whole difficulty of the closeness of the object to the lens is overcome.

Several hundred years ago microscopes were made with separated lenses which gave this increase of so-called working distance, making it possible to thus use high powers conveniently; but it may be safely stated that their inventors, who produced their instruments by experiment, had no notion as to why the result was obtained.

The second chief defect of the simple microscope was seen to be the practical difficulty of making sufficiently powerful single lenses. To

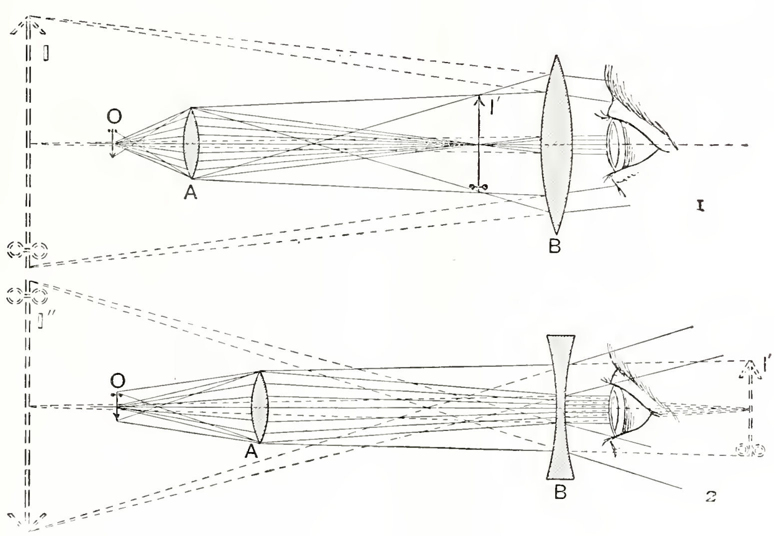
* "The Consideration of the Equivalent Planes of Optical Instruments," by Conrad Beck. Transactions of the Optical Convention, 1905.

overcome the defect, the first expedient to suggest itself would be to make an enlarged image with one lens, and then to further enlarge that image by examining it with a second lens, then a third, and so on. This has been the method which was actually employed to produce what is now known as a compound microscope. By this means of combining two simple microscopes into one instrument, as much magnifying power can be obtained as can be advantageously used. The two portions represent two of the methods of using a simple lens as a microscope. The one, called the object-glass, because it is nearest to the object, is used to project an image into space behind it, as in Fig. 1 (3), and the other, called the eyepiece, as being close to the eye, is in principle nothing more than a simple microscope for magnifying the image produced by the object-glass, as Fig. 1 (5).

The simplest form of compound microscope, and one which was actually constructed some hundreds of years back, consists of two simple convex lenses used in exactly this manner. The modern instrument is essentially of the same type, although, for reasons which will more fully appear in a later lecture, the object-glass consists of a number of combined lenses, and the eyepiece consists of at least two components.

The object-glass must always be a positive lens, but the eyepiece may be made upon two designs. It may be a convex or positive lens in principle—that is, a magnifying glass as in Fig. 1 (5)—or it may be a concave or negative lens. This will appear surprising, because when investigating concave lenses we have been accustomed to believe that they are incapable of producing images at all. We know that any positive lens will give us an image of the sun, and may be used as a burning-glass. We know also that we may try in vain to obtain an image with a negative lens. The reason for this is because all the light given off by objects in nature is divergent; it is spreading out from points, and a positive lens is required to form an image with divergent rays. If converging rays were to be met with in nature it would be recognised that negative or concave lenses could form images. Fig. 16 illustrates how images are formed by the object-glass in both by a positive eyepiece lens in the first, and a negative in the second diagram.

FIG. 16.



In the case of 1 the positive eyepiece B forms a virtual image of the rays diverging from the image I'. In the case of 2 the negative eyepiece is placed so as to intercept the rays at a point before the image I' is formed, at a position where the rays are converging, and can consequently form a similar virtual image at I''.

Both these combinations give the same magnifying power, but it will be observed that when the negative eyepiece is used the object-glass is further away from the object than when the positive eyepiece is used. So that as far as magnifying power is concerned it is as good as the positive eyepiece, and as to the working distance or distance of the object

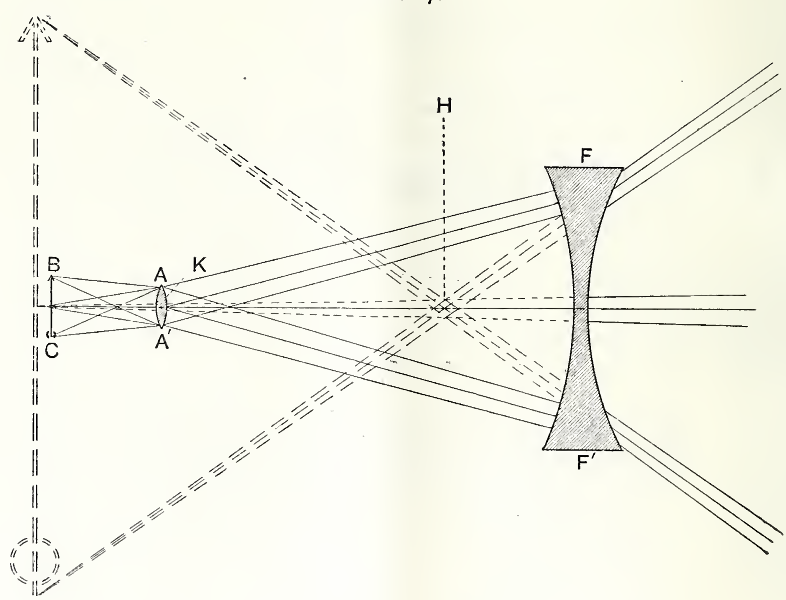
from the lens it is much better. It also does not invert the final image, so that it would appear to be the better eyepiece to adopt, but its disadvantage lies in the fact that only a minute portion of the object is seen at once. It has a very small field of view. Nevertheless in dissecting microscopes where an erect image and large working distance are required it is still in regular use under the name of the Brücké lens. Neither of these forms have completely overcome the difficulty of giving a small field of view.

To thoroughly understand this question it will be necessary to consider what is the condition required in order to give a large field.

A little consideration will show that this disc is a conjugate image of the aperture, or more correctly the back equivalent plane of the object-glass A A′, as the three rays which pass through the centre of the lens aperture at K meet again at B. This conjugate image of the aperture of the object-glass is called the Ramsden circle, or the eyepoint, and in order to have a large field this must exist outside the instrument in some position where the eye can be placed, which evidently cannot be achieved by a negative lens.

Let us now consider the case of a positive lens. The action of such a lens is shown in the diagram (Fig. 18). A virtual image of the

FIG. 17.



This condition is that rays proceeding from all parts of the object must be collected into a sufficiently small area to enter the pupil of the eye, and that this area must exist in some position where the eye can be placed. The case of a negative eyepiece will first be considered.

The diagram (Fig. 17) shows that here the light afer having once entered the microscope continues to expand, and there is no collecting of the rays throughout the entire course. It is true that all the rays pass out of the instrument, as if they had all passed through a small circular space at H. The rays both from the points B and C, and in fact all other parts of the object appear to have passed through this area, and if the eye could have been placed at such a point, the whole of the object would be seen.

object is formed in the usual way and the light is at the same time focussed down to a small area H outside the instrument, the Ramsden circle at H being a conjugate image to the aperture A A′. As the object-glass is in most microscopes a considerable distance from the eyepiece the Ramsden circle will be formed near the focus of the eye lens, and its size will be in the ratio of the distance of the object-glass A F, compared to the focus of the eyepiece F H, and will under ordinary circumstances be an image reduced in size. This is exactly what is required, as the pupil of the eye is small and cannot receive a large bundle of rays.

A positive eyepiece is therefore the best form, but such a positive lens has to be very large in order to collect the whole cone of light. Large lenses are not capable of being

made of high power because their curvature cannot be great. To overcome the difficulty the Huygenian eyepiece consisting of two lenses, one large and one small, was devised. The total power is nearly as great as the smallest of its lenses, and its light-collecting capacity is much greater than its largest lens. This eyepiece might be investigated by examining one lens at a time, but the problem can be much more easily dealt with when examined by the Gauss method of an equivalent lens to represent the complete system. In fact this will prove to be a good illustration of the advantages of using this system for broad optical problems.

The focus of its equivalent lens and the position of its equivalent planes must be worked out by the ordinary formulæ or obtained by experiment. These planes will be found to occupy curious positions; they are crossed over, the equivalent lens exists at E to receive the light from the object-glass, and must be pushed backwards to E′ to discharge it into the eye. (Fig. 19).

FIG. 18.

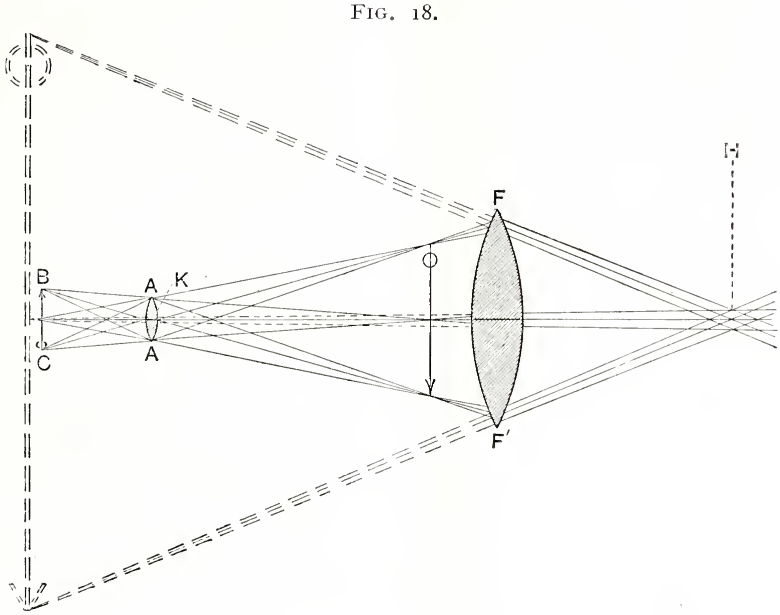
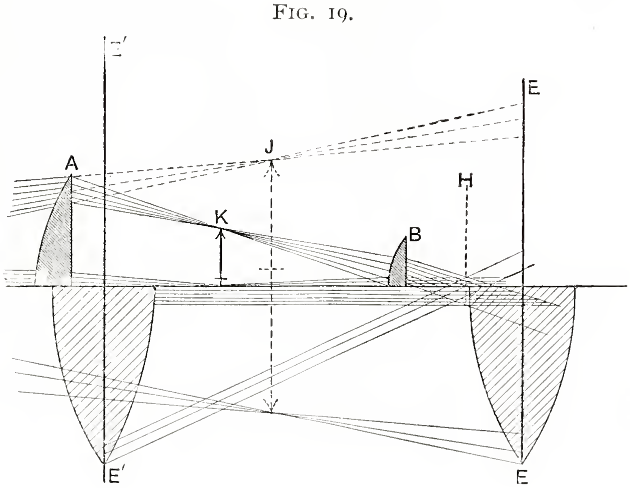


FIG. 19.



The upper part of the diagram shows the actual course of the rays through the Huygenian eyepiece, the lower portion shows its equivalent lens made just large enough to receive the whole cone of light when placed at the position E, and illustrates the size that a single lens eyepiece would have to be. Such a large lens would not be satisfactory, but sup-

posing for the moment that it did exist at the point E, the light would emerge to a position far to the right of E, but remembering the characteristic of the Gauss equivalent lens, it

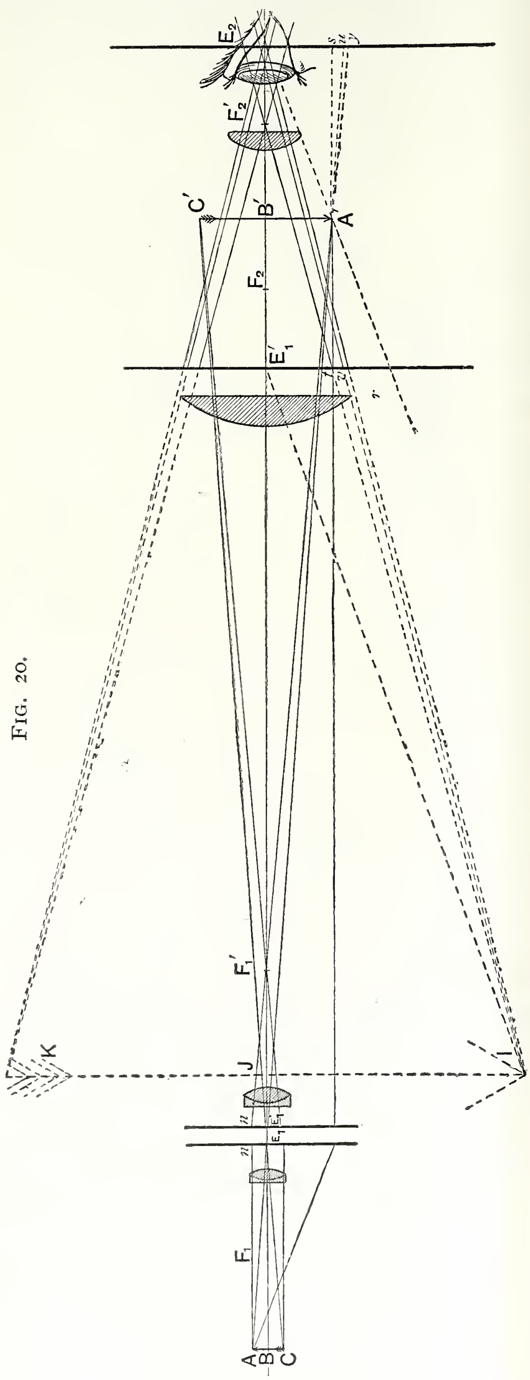


FIG. 20.

must having received the light at E be pushed back to E′ to discharge it, and it emerges to H, and that is the Gauss method of explaining what actually happens in a Huygenian eyepiece.

It will be noticed that neither of the actual lenses employed need to be of as large a size as the equivalent lens. For if the equivalent lens be placed at E, its position for receiving light, a lens placed at A need not have as large a diameter to transmit the whole cone, and when the equivalent lens is placed at E′ to discharge the light, a lens placed at B may be quite small, and can be made of deep curvature.

Thus great advantage is obtained by this form of eyepiece by enabling smaller lenses to be used, the upper lens being of considerable curvature and high power, and the total power of the eyepiece is almost as great as that of the upper lens alone.

It also will appear in a later lecture that this form of eyepiece is peculiarly capable of being corrected for aberration errors. The total magnifying power of the eyepiece is dependent upon the focus of its equivalent lens, and for that purpose the latter may be used as a perfect substitute. The size of the Ramsden circle may be calculated in the usual way by finding the distance of the object-glass equivalent plane from the plane E, and the distance of the Ramsden circle from the plane E′ the ratio of their distances will give the relative size of the object-glass aperture to that of the Ramsden circle.

The upper half of the diagram showing the actual path of the rays, illustrates that the lower or field lens collects the image that would have been formed by the object-glass at J, before that image is actually produced, and cones it down to a slightly smaller image at K, from which the eye lens B produces a virtual image in the usual manner.

The general optical construction of a compound microscope, has now been reached, and Fig. 20 shows the course of the rays throughout the system.

The magnifying power of a simple microscope has been considered, it has been shown to be a constant quantity dependent upon its focus. The distance at which a virtual image formed at its means is assumed to exist, is always taken at 10 inches, therefore 10 inches divided by the equivalent focal length of a single lens is a measure of its power. The eyepiece of a microscope is essentially a simple microscope used to examine the image formed by the object-glass. The question as to whether the virtual image really does exist at its assumed position of 10 inches from the eye, or whether, due to accommodation, it actually exists at another point, introduces a

slight modification, but does not seriously invalidate the fact that a 2-inch eyepiece magnifies five, a 1 inch, ten inch, and so on.

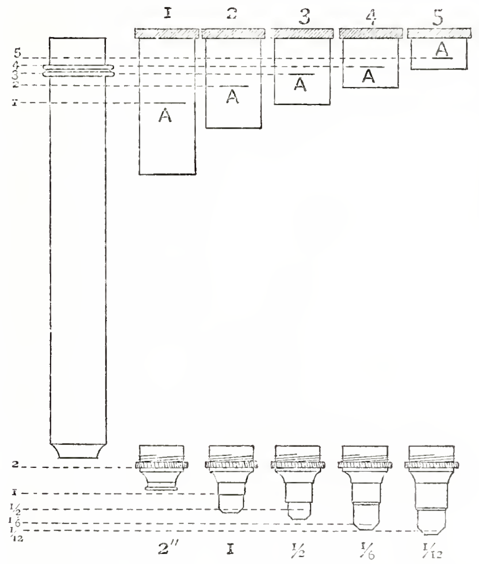
Thus the power of the eyepiece is easily ascertained, and the power of a microscope is best considered in connection with its two component parts, the object-glass and the eyepiece. The power of a field glass or telescope is often considered as a whole. If a field glass magnifies ten diameters, it is left to the decision of the optician as to how much shall be done by the object-glass, and how much shall be done by the eyepiece, but a microscope is provided with more than one object-glass, and more than one eyepiece, in order that different magnifying powers may be obtained with the same instrument.

As different combinations can be made, the part played by each portion must be understood by the observer.

The magnifying power of the object-glass is a matter of more complexity. As illustrated in a previous diagram, a lens will produce an actual image of an object with different degrees of enlargement according to the positions of the object and its image with reference to the lens. The magnifying power therefore depends on the equivalent focus of the lens in connection with the tube length of the microscope. If a microscope has a longer tube the image will be formed further away, and the image so formed is larger than if the tube were shorter. It must be ascertained therefore in expressing the power of an object-glass what is the tube length of the microscope on which it is used. This sounds simple enough. The objection that microscopes are provided with a telescopic tube is no difficulty because a draw-tube, as it is termed, is graduated. The effect of increasing the power by extending this tube can readily be calculated. That is no doubt true, but the calculation is not quite so easy as might be supposed, and for this reason. A microscope may have a tube length of 140 milimetres, a revolving nosepiece may be added increasing it to say, 150, the draw tube may be pulled out ten millimetres, making a standard tube length of 160 millimetres (a standard tube length for short microscopes generally adopted); but what relation does the mechanical tube length bear to the magnifying power of the object-glass. The size of the image formed by the object-glass will depend on the position at which it gives an image that will be focussed by the eyepiece. Now the eyepieces have all different focal lengths and drop into the microscope body, so that the point marked Fig. 21 (A), where the image will be formed will vary with each. The object-glasses are all different lengths, and their back equivalent planes are in different positions with reference to the tube of the microscope. So that the mechanical tube length gives no clue to the optical distance between the eyepiece and object-glass. It might at first sight be considered a bad piece of design.

The eyepieces could no doubt be made to project from the tube to varying extents so that the positions A should all occupy the same plane, but the microscopist who had just arranged his instrument to the exact

FIG. 21.



height for comfort would object to having another inch and a half added when he wished to change his eyepiece, while it would be impossible to arrange on a binocular microscope, as the distance between the eyes would be changed by a change of eyepieces. As to object-glasses, a 2-inch would require a mount nearly an inch longer than a 1-6th, which would never be tolerated. It is now the general practice to make object-glasses of such a length that when they are swung round on a revolving nosepiece they are approximately in focus. This requires that the lower powers should be shorter and not longer than the higher.

An attempt was made in the early days to get over the difficulty by calling the object-glass by a focal length, which was incorrect: thus an old 4-inch object-glass had actually a focus of about $2\frac{1}{2}$ inches, but gave a magnify-

ing power approximately the same that a 4-inch would have given had it been mounted further from the tube, to fulfil the tube length condition. The system did not work satisfactorily, as it was based on an error, and calculation was rendered by its means even more difficult.

It should be remembered, however, that an eyepiece is an instrument that by its nature always gives a constant magnifying power, while the object-glass varies with the tube length employed. A system of making the eyepiece magnification vary with the tube length has been suggested, and to some extent adopted, but this method is wrong in principle, and in consequence leads to serious additional complication as soon as the conditions are varied, as, for instance, in projection microscopes and photo-micrography.

It is worth noting as a rough guide that a 1-inch object-glass with an 8-inch tube magnifies, in the neighbourhood of six diameters, a half-inch, 12 and so on, with a 10 inch tube, the 1 inch would give about 10 and a half inch 20 diameters, but for greater precision maker's catalogues should be consulted, while for accurate work the magnifying power should be measured with a micrometer.

We have now seen the broad lines on which a compound microscope is constructed: How great magnifying power, combined with a large field and sufficient working distance is obtained. In the next lecture we shall consider the *defects* of such an instrument constructed of simple lenses, and how they are corrected.

COTTON-SEED PRODUCTS IN INDIA.

There are many valuable oil seeds grown in India. In the majority of cases the seeds are exported to foreign countries, the oil extracted and returned to India, or sold elsewhere at an advanced price. To retain in India the manufacturing profit, oil mills have been started in several places, and others are being projected. These are for linseed, rape or sesamum oil seeds. The native newspapers are trying to start a movement in favour of cotton-seed mills, but the exporters of cotton seed do not seem to favour this. According to the special agent of the United States Government, who has been making an inquiry into the question of the utilisation of cotton-seed products in India, there is only one regular cotton-seed oil mill in all India, and that is in Burma. This mill is at Myingyan on the Irrawaddy. Seed cotton is purchased wholesale in Burma, also some from Bengal and Madras, ginned at the ginning plant connected with the oil mill, the cotton sold, and the seed then crushed, the oil extracted and refined, and the residue made into soap. Being situated on the Irrawaddy the factory is well located in regard to water traffic with eastern India. Besides pressing its own seed the mill at Burma presses seed for merchants at the rate of sixpence per maund of forty pounds, or if seed cotton is supplied, the charge for ginning and then pressing is eightpence per maund. Crude oil and refined oil and soap are made from cotton seeds. Ordinarily from a maund (40 pounds) of clean seeds there are obtained about twelve pounds of lint, from six and three-quarters to seven pounds of oil, nineteen pounds of oilcake and meal, and the remainder hulls. This average, however, varies with each season. Making crude oil from cotton seed is simply a mechanical process, consisting of cleaning the seed and separating the short lint from the seed, removing the hull from the kernel, cooking the meal to the proper consistency for pressing, and then squeezing out the oil, leaving the pressed cake. Refining the oil is a chemical process consisting of mixing the crude oil with either caustic potash lye of 45° Baumé (3 gallons to 100 gallons crude oil) or else with 30° Baumé (6 gallons to 100 gallons crude oil), heating and stirring, and then allowing to cool and settle when the clear oil is poured out, leaving the brown soap sediment. Both processes are carried on with native workmen. The press used has a ram 12 inches in diameter and is worked at a pressure of $1\frac{1}{2}$ tons per square inch. As usual the pressure is applied by pumps, one set having $2\frac{1}{2}$-inch and the other set 1-inch diameters, the larger pumps applying the pressure quickly until the meal is well compressed, when the small pumps give the final squeeze. Fifteen minutes suffice to completely extract the oil, which collects in a reservoir underneath. The oil as extracted is a deep red colour, and weighs $7\frac{1}{2}$ pounds to the gallon. There is a large demand for the oil as a lubricant for railways, &c., and a good deal is used in the crude state without refining. The refined oil is used for culinary purposes in India and also in Japan and China. The remaining residues of oil are used in the manufacture of soaps. The selling price of this soap varies according to quality. The residues of hulls are used for fuel, but could be converted into potash and phosphate of lime. Forty pounds of seed produce 19 pounds of pressed cake, which is sold in Burma and India for cattle food, and the Chinese use it for fuel to a small extent. Some is exported to Japan for use as cattle food and fertiliser. This is sold by the market weight "tokari," which is equivalent to 40 pounds net, being the same as the local Burmese maund. It is packed in gunny bags containing three to six maunds of oil cake each. Japan uses annually immense quantities of bean cake for cattle food and fertiliser. In Burma, India, China, and Japan, cotton-seed oil is preferred to lard oil for culinary purposes, and it is claimed that for "shortening" and for pie crusts it is superior to lard, both

as to taste and appearance of the finished crust. There should be a good demand in India, especially because lard is absolutely forbidden to Mohammedans, and to some other religious sects as well. Refined cotton-seed oil has the colour, transparency, and taste of olive oil, and the same characteristics for lubricating and pharmaceutical purposes, according to the special agent. Olein is the characteristic ingredient of each. The special agent adds that it is almost impossible to distinguish a good cotton-seed oil from olive oil, and the former is frequently employed to adulterate olive oil, about twenty-five per cent. cotton-seed oil to seventy-five per cent. olive oil being the proportions used. The Indian cotton-seed oil, however, is not as clear and pure as the American oil, nor of exactly the same taste or colour, so it is not so well suited for this purpose. Owing to the absence of the gum that always exists in lard oil, cotton-seed oil is a better lubricator and luminant than the former. It burns longer, and gives a brighter light, and this is one of the main uses to which the crudely extracted native oil is used in India. Being a fixed oil, it is non-volatile and, therefore, non-explosive and safer than kerosene, or similar oils. The production of light coloured soap from crude cotton-seed oil, or from the residues, is obtained by purification. The oil is freed from impurities by settling or filtering. The residues are slightly warmed with a little water, and after cooling, drawn off from the aqueous layer. The oil or the residues are then treated with sufficient strong soda lye so that the soap separates in flakes, which are removed from the strongly coloured under layer. The soap is dissolved in as little water as possible, and decolourised by the addition of chlorine water. Instead of the latter, bleaching powder or potassium permanganate can be added, and afterwards acids. By the addition of an excess of such acids purified sebacic acids are separated. To remove the odour of soap made from cotton-seed oil, the oil is sometimed boiled with an equal quantity of 25 per cent. soda lye for three or four hours. In making a lubricant for industrial purposes there are melted together 130 pounds of castor oil, 20 pounds of animal fats, and 40 pounds of crude cotton-seed oil. Forty pounds of Indian meal are then added, and the whole boiled for thirty minutes. In making a lubricant from the oil residues, 500 parts of the oil residues and 100 parts of the water are placed in a kettle of suitable capacity and brought slowly to the boiling point. When all the oil is dissolved there are added 40 to 50 parts of hydrochloric acid of 8° to 10° Baumé, and the mixture boiled and stirred for half-an-hour. At the expiration of this time, if the decomposition is complete, the acid forms a combination with the oil residues and the grease is liberated in the form of a thick oil. After resting for 24 hours the water containing the salts and excess of acids is drawn off, and the oil several times washed with a large quantity of water to free it from the last traces of acids. It is finally mixed with 10, 20, or 30 per cent. of tallow, the quantity depending on the thickness of the oil. The interest that is being taken in cotton seed at this time in India is done in part to an agitation being carried on by some of the native papers in favour of local manufactures. They claim that the increasing export of oil seeds from India is a great drain on the fertility of the country, a very small proportion being returned as oil cake or other material that will finally return to the soil; also that if manufactured in India not only would the fertilising portion of the seeds return to the soil, being applied direct or used as cattle food, but that the manufacture would give employment to many and yield a return on capital. In 1906 the export figures for all the oil seeds except linseed, including cotton seed, rape, sesamum, castor, poppy seed, &c., showed decided increases, and the demand has caused a rise in price, and on most of the seeds the prices tend to rise still higher. Cotton seed has always been considered a valuable product in India, the percentage of oil making it a safe food in most cases, notwithstanding its high percentage of husk and woolly fibre. Cotton-seed oilcake is practically unknown in India, although other oil seeds—sesamum, rape, safflower, ground-nut, &c., are pressed in every large village, and cake obtained therefrom, and food for cattle. In the cities these seeds are now pressed by hydraulic machinery, and linseed cake exported to Europe. At Lahore and Akola there are hydraulic press mills capable of dealing with cotton seed, but at present they are at work on other seeds. A sample of Indian cotton seed was recently sent from Baroda for examination to ascertain what quantity of oil could be chemically extracted from it. The test was made at the Techno-Chemical Laboratory in Bombay, and the sample was found to yield 20·9 per cent. of oil.

BRITISH TRADE WITH CHINA.

In his exhaustive report on the foreign trade of China for the year 1906 (Cd. 3927-26), Sir Alexander Hosie, acting Commercial Attaché to His Majesty's Legation at Pekin, refers to the misleading character of the returns of the Imperial Maritime Customs as they affect British trade with China. For example, those for 1906, which give the value of Chinese imports from the United Kingdom to China as £43,623,867, and of the exports from China to the United Kingdom at £16,851,626, making a gross trade of £60,475,493; but this is much too high, while the figures relating to the imports from and exports to other countries are much too low. The anomally is explained as being due in great part to the interposition of Hong Kong, where large percentages of goods from and to foreign countries are transhipped, and their origin and destination being thereby officially unascertainable by the Customs

they are credited as imports from and exports to the British colony, which, unfortunately for the attainment of exact data, publishes no detailed statistics of its own trade or its re-exports. The Statistical Secretary to the Imperial Maritime Customs, in his report on the foreign trade of China for 1906, estimates that these transhipments amount to about 40 per cent. of China's foreign trade, and the value thereof has to be apportioned among foreign countries, including, of course, the British Empire. He has been at great trouble to collate the available annual returns of all countries trading with China and Hong Kong, which, for the purpose of this investigation, he includes in China's commercial area, and the conclusions at which he has arrived may, in spite of the diversity of fiscal years, be accepted as approximately correct. According to a table given by Sir Alexander Hosie, and compiled from the Statistical Secretary's figures, the British Empire supplied China and Hong Kong, in 1904, with 50·46 of their imports, and took 20·01 per cent. of their exports. In the same year, the British Empire's percentage of the total foreign import and export trade of China and Hong Kong was 37·47, 23·92 of the imports coming from, and 7·72 of the exports going to the United Kingdom, and 21·70 of the imports coming from, and 3·49 per cent. of the exports going to India. In 1906, according to the tables of the Imperial Maritime Customs, £60,475,493 of the gross trade of China, out of a total of £109,406,281, is credited to the United Kingdom. British shipping supremacy in China waters is maintained. In 1906 the British flag carried 47·11 per cent. of the foreign and 47·90 per cent. of the coast trade of China, the balance of the percentages in the foreign and coast trade being respectively divided between the flags of fifteen and sixteen other nations, including China, whose flag, although beaten by the Japanese for the second place in the value of the foreign trade, had a higher tonnage, and was an easy second in the coast trade both in tonnage and value. In the combined foreign and coast trade the percentage of tonnage under the British flag was 44·12 per cent., followed by the Chinese with 21·35 per cent., Japanese 15·01 per cent., German 9·86 per cent., and French 4·12 per cent.

FOREST PRESERVATION IN FRANCE.

In no country in the world, is the work of conserving and reconstituting the forests carried on with greater energy and skill than in France. The extensive denudation of the primeval forests began on a large scale during the early centuries of the Christian era, and continued so unremittingly that Colbert, the great minister of Louis XIV., exclaimed in the seventeenth century, "France will perish for lack of wood." The damage wrought by forest destruction in France had far exceeded that which is now deplored in the United States, when the evil was at last realised, and systematic attempts were commenced to correct it. According to the American Consul at Marseilles, as early as 1824 the National School of Waters and Forests was founded at Nancy, for no other purpose than to provide recruits for the higher branches of the public forestry service, and at the present time this service has within its comprehensive grasp every portion of the country, which for forestry purposes is divided into 32 "conservations." The work is directed from the Ministry of Agriculture by a director and three administrators. Their duties include the conservation, exploitation and improvement of public forest lands; the fixation of dunes upon the maritime littoral; the replanting of trees on mountains and the correction of mountain torrents; the regulation of the pasture lands of the communes and the utilisation of water in the pastoral and forest regions, and the surveillance of river fishing and fish culture. Each of the 32 conservations is in charge of a conservator aided by an adjutant-inspector. The conservations are divided into "chefferies," each administered by an inspector or adjutant-inspector, and these are again subdivided into "cantonnements," with adjutant-inspectors or general guards in control. Each of these higher officers has appropriate military rank. They direct the transactions of a considerable army of foresters of various grades and classes, of whom 3,300 are recruited and paid by the national government, and many more by the communal governments. The superior officers, who number 747, are selected from the National School of Waters and Forests at Nancy, from the graduates of the Secondary School of Forestry at Barres, and from such foresters as have had fifteen years' experience and are able to pass the severe examination. There are in France two other schools—one at Barres and one at St. Pau—where private foresters receive instruction. At the present time a total area of over 7,000,000 acres is under the direct control of the forestry service, of which over 6,000,000 consist of forests properly so called. The far greater proportion of the forest area—4,500,000 acres—belongs in fee to the communes, but is under the strict control of the State, experience having demonstrated that the communal governments could not be relied upon to maintain the public property. With such success has the State carried on this supervision that, according to the consul, there are communes where, within six years, the municipal revenues from the forest lands have increased 300 per cent. and are still increasing. France appears to have definitely resolved that it shall not perish as Colbert predicted "for lack of wood." The work is slow—it will require probably 200 years to bring it up to its maximum effectiveness—but the time is foreseen when existing damaged forests will be reconstituted, and when all the waste spaces will be replanted to the point of proper proportion to ensure the conservation of the water supply, and to furnish the timber and

wood required by the population. The effect upon private forest landowners of this public work has been most salutary. The ruthless cutting down of trees has ceased, and the exploitation of private forests proceeds to a fairly large extent upon the same lines as that of the public wooded surfaces. In each conservation there are numerous nurseries where seedlings are grown, each one being transplanted at the age of three or four years to its assigned place and then protected against the sun by a carefully placed stone or piece of sod, being thereafter visited regularly by lynx-eyed foresters. In general, the French foresters prefer to replant with native species.

THE ITALIAN COTTON INDUSTRY.

The rapid growth of the cotton industry in Italy during the past twenty years, and the consequently enlarged volume of Italian export trade in piece goods, are conditions worthy of careful investigation and study on the part of cotton manufacturers and exporters generally. The cotton mills of Lombardy number about 500, or about 60 per cent. of the total number for the whole of Italy; the number of looms throughout the country, exclusive of hand looms, being estimated at 150,000, with 5,000,000 spindles, employing 300,000 people. The weaving machinery found in Italian mills is practically all of English make. Ten hours usually constitutes a day's labour, for which women receive a wage of from one shilling and threepence to one shilling and eightpence, and men from two shillings to two shillings and sixpence. The cultivation of cotton in Italy is insignificant, the yield averaging not more than 10,000 bales. According to a recent report by the American representative at Genoa, a project is on foot for the extension of its growth on an important scale. During the American Civil War, a large amount of cotton was produced in Italy, and its extensive cultivation was continued until 1871, when about 198,000 acres were devoted to it. Cotton fields were then turned into vineyards, as yielding more satisfactory export returns, owing to the scarcity of wine in France. Much attention has of late been given to scientific agriculture. The country is also making an effort towards cotton growing in Argentina; in fact, for more than ten years, Italians interested in the South American trade have been attempting to cultivate a cotton crop in Argentina, with fairly successful—though gradual—results. In 1905, the estimated area under cultivation was 10,000 acres. Several companies, with Italian capital, have been organised to exploit the field, and are actively at work, one company having exported about 2,000 bales of 500 pounds each. The total amount of the annual importation of raw cotton is estimated at 700,000 bales, of which 500,000 are imported from the United States, 100,000 from India, and 30,000 from Egypt. From January 1st to September 30th, 1906, cotton to the value of £7,500,000 was imported into Italy, an increase over the corresponding period of 1905 of £600,000. The export of cotton goods from Italy during the same period in 1906 amounted in value to £3.163,000, an increase of £460,000. Turkey, Roumania, Bulgaria, Egypt, South America, India, and the Philippines, are the principal foreign markets for the Italian cotton export trade. Twenty-five years ago Italy was one of England's best customers for cotton tissues; now she is becoming a strong competitor in the markets of the world. The South American market for Italian cottons was developed on the reports of an expert who went from Italy some years ago to make a study of probable outlets for the then projected cotton mill system which has since grown up in Lombardy. It was made possible by the large number of Italians emigrating to South America for settlement, and is an excellent illustration of the value of trade which follows in the footsteps of the emigrant. Upon the demand created by them was erected the large volume of business now enjoyed. The familiar method of putting trained travellers into the field, was followed up in a way which might be imitated by other countries with advantage. No man unable to speak the language of the people whom they had to visit were sent out, and before they went, full instructions, based on the careful plans of campaign drawn up by their superiors, were given. Transportation facilities were studied. And then, as the crowning effort in the entire scheme, transportation lines were created in order that the trade might be carried in Italian bottoms, and controlled by Italian hands. Too much emphasis cannot be laid on this successful establishment of direct and perfectly equipped steamship lines between Italian home ports and South America. In Uruguay, as in other South American countries, Italian cotton exporters have found their greatest aids in the banks established in the large centres of trade by Italians, backed by home capital. These banks stand as sources of quick and certain information concerning every phase of the business, and have been used to draw up reports not only on the standing of clients, the conditions of the money market, the probable demands for credit, &c., but on market conditions and on observations concerning the trade of rival nations. Importations of Italian white and coloured cotton textiles into Argentina increased from 3,964 tons in 1901, to 4,843 tons in 1905. The extent of this industry may be realised when it is remembered that Argentina has only 6,000,000 inhabitants. A similar increase occurred in cheese and vermouth. Italy sends to the Chilian market large quantities of dark-coloured mixtures for trousers, generally worn in the south of Chili, the lighter goods used in the northern and centra portions of the country being furnished almost entirely by Germany. Italy also supplies upholstering materials to that market.

HOME INDUSTRIES.

The Hop Position.—At a recent meeting of the East Kent Chamber of Agriculture, a resolution was passed recommending that a duty of £2 per cwt. should be placed on imports of foreign hops. It was urged in support of the resolution that for every acre grubbed up in Kent another was planted abroad. Messrs. Barth and Son of Nuremberg, who are recognised as authorities on the hop crop, have just published their annual estimate of the world's hop crop for 1907, and they give tables which indicate the area under hops in the last six years. Their figures show that whilst the area in the United Kingdom under hops has declined by 2,500 hectares, that of the rest of Europe has increased in the same period in round numbers by 6,000 hectares, whilst in the United States the increase over the same period has been a little more than 5,000 hectares, the one decrease being in Australia, where the area under hop cultivation fell from 1,000 to 580 hectares. It is noticeable that everywhere on the Continent, and in America, as well as England, the growers complain of the narrow margin of profit, and American growers say that if a duty were imposed by the United Kingdom it would not pay them to send hops here. However that may be, it is certain that the margin of profit in England from hop growing is so narrow that a continuance of the contraction of the cultivation may be looked for unless prices improve. The Kent growers contend that a duty of £2 per cwt. would keep out foreign hops, and enable them to supply all that are wanted for the home market, but assuming the willingness of Parliament to impose the duty, and the contemplated effect upon imports, the home hop grower might not derive any continued advantage, seeing that if foreign imports were practically excluded by duty this exclusion would probably lead to an extension of the acreage under hops that would soon reduce prices to the old level.

Cotton Growing within the Empire.—There is no difference of opinion as to the desirability of obtaining our cotton supplies from within the Empire. The only question is whether it is practicable to do so within any measurable distance of time. Mr. Birtwistle, the Commercial Intelligence Officer of Southern Nigeria, has just prepared a paper in which speaking of Nigeria, he says, "to me it appears that we have in Nigeria a proved cotton-growing country, and a large agricultural population, with more than sufficient land available to eventually produce, if needed, the whole of the Lancashire requirements of raw material, and of the American quality." It is admitted that the soil of Nigeria produces cotton equal to the American quality, that the extent of the area in Nigeria where such cotton can be produced is more than sufficient, if fully cultivated, to supply the present, and any probable future, wants of Lancashire; and that there is labour in Nigeria sufficient for the cultivation indicated. But it does not follow that there will be any very rapid growth of cotton cultivation in that dependency. Taking the figures of the last six years, considerable progress is shown in cotton cultivation within the Empire. In 1902 the value of raw cotton imports into the United Kingdom from British Africa and the West Indies was only £7,326. In the first ten months of the present year it had risen to £258,617, or to put it in weight, the exports increased from 3,823 cwts. in 1902 to 58,689 cwts. in the first ten months of 1907. And there has been considerable increase in the cotton imports from Nigeria, but nothing like a large export of cotton from that colony can be looked for, until transport has been improved. The completion of the Kano Railway will, there is every reason to hope, have the effect of increasing largely the export of cotton, and as railway communications are extended, cotton exports will, no doubt, continue to increase. Cotton cultivation is essentially a black man's work, and the cotton cultivation of Nigeria must rest upon the willingness of the natives to grow cotton for export. They have grown it for their own use from time immemorial, but they will not grow it for export unless they can get a price which pays them better than other forms of labour, and here comes in another difficulty which has to be reckoned with in undeveloped countries like Nigeria when competing with the highly organised cotton industry of the Southern States of America. In America, machinery reduces the cost of production, and there would have to be machinery in Nigeria if it is to successfully compete with the Southern States in this market. So far as prices go, the tendency would seem to be upwards. The demand of the world for raw cotton is now growing more rapidly than the increase in supplies, and we are not likely to see cotton again down to 4d. This tendency of prices upwards should quicken the extension of cotton-growing within the Empire, but it is to be feared that many years must elapse before what may be called Empire-grown cotton, outside India and Egypt, will compete very seriously with the product from America.

Electrical Propulsion.—Experiments recently made by the New York Central Railway Company seem to show that, conditions being equal, a light electrical locomotive will haul a load of given weight at a higher speed, and with greater powers of acceleration, than a steam locomotive. Two trains, identical in weight, ran side by side upon an ordinary railway track with easy gradient, and curves of average radius. One was a steam, and the other an electric locomotive train; both were of the latest design, the former weighing 108 tons, and the latter 90 tons. In the first run the electrically hauled train came in two lengths ahead, and reached a maximum speed of 57 miles, as compared with the steam engine's 50 miles. The experiments were made upon a 6-mile stretch, and there were six runs, the result of all of

them being the same, namely, a victory for electricity. In the last two trials the electric locomotive was run at full speed, with one coach attached; its maximum speed being 79 miles an hour, and without any coach, over 80 miles an hour. If the precaution had not been taken of shutting off the power when rounding curves, a speed of 90 miles an hour might have been reached.

The Embargo on Canadian Cattle.—For years past strenuous efforts have been made by the Canadian Government to induce the Imperial Government to remove the restrictions imposed in 1893 on the importation of Canadian cattle into the United Kingdom for store purposes, and purposes other than slaughter. Recently the secretary of the Association of Chambers of Commerce addressed a letter to the President of the Board of Agriculture expressing the opinion that these restrictions ought to be removed in the general interest of both countries, but this can only be done by Parliament amending the present law. The reply of the Board of Agriculture to the Associated Chambers of Commerce is to the effect that the subject is receiving attention. Much the same reply has in past years been given to similar communications made with a similar object. On the face of it the position of those who are urging that the restrictions upon free importation ought to be removed is a very strong one. They were imposed with the object of protecting the herds of the United Kingdom from the terrible scourge of pleuro-pneumonia, and they have done this very effectively. In November, 1893, the British Government issued an order requiring all Canadian cattle landed in the United Kingdom to be slaughtered within a limited time at the port of landing. Until 1893 Canadian cattle had been free to be moved from place to place in the United Kingdom, and it was possible to hold them over from one market to another, There was a considerable trade done, too, in "stockers," half-fed animals which British traders bought and fed up for market. The order of November 1893 was due to the alleged discovery of a case of pleuro-pneumonia in an animal from Canada that had been landed in Scotland, but it was claimed to have been proved that it contracted the disease in Scotland. However that may be, there has not been for the last seven years a single case of pleuro-pneumonia in any of the Canadian cattle landed in Great Britain, and if ever Canadian cattle are again allowed to move about in in this country there would seem to be a good deal to be said in favour of allowing them to do so without further delay.

Cotton Spinning Profits.—Mr. J. Kidyer, of Oldham, has prepared an interesting analysis of the profits earned during the present year in the cotton spinning trade. They establish a fresh record of profit-making. Mr. Kidyer takes one hundred companies having a share capital of £3,722,780 invested, together with £2,377,466 borrowed capital, either by way of mortgages, debentures, or upon short date loans. Thus the hundred companies are not all among the best, or most up-to-date companies possessing the newest plants, they include mills that have been in existence over thirty years. The capital employed by these one hundred companies has earned, after making allowance for wear and tear of plant, £1,321,157 net profit, or nearly 35½ per cent. This gives an average profit per company of £13,211 against £6,555 for 1906. The dividends and bonuses show great improvement, the average being 15⅞ against 9⅔ per cent. paid last year. If the interest at the rate of 4 per cent. is allowed on the £2,377,466 borrowed capital, or say, £96,000, the total profit earned on the combined share and loan capital of £6,100,246 would have amounted to £1,417,157, which works out to nearly 23¼ per cent. on the total capital employed. It was said above that the one hundred companies which give these remarkable results are not a selection of all the best equipped companies For instance, an examination of eighty other companies of modern erection and equipment, which never disclose trade profits, reveals an average dividend and bonuses declared of over 17⅞ per cent. against the 15⅞ of the one hundred companies which issue accounts. The situation throughout the year has been so favourable that a large number of new mills are being erected, and before the end of next year, the output will be materially increased. The outlook for 1908 is much less reassuring than it was for the present year. Apart from the fact that the cotton industry has now had three seasons of great prosperity, and that an unbroken spell of prosperity seldom lasts longer in this industry, there is not only some uncertainty as to the supply of raw cotton in the coming year, there is much unrest in connection with wages. The dispute between the Federation of Master Cotton Spinners' Associations and the Card and Blowing Room Operatives' Amalgamation on the question of an increase in ring spinners wages has become more acute owing to the circular of the Master Cotton Spinners Federation reviewing recent developments in the dispute, quoting the resolution passed at the mass meeting of employers held at Manchester on the 16th, which threatens the close of all the mills in the Federation, and intimating that the resolution will be put into operation without delay.

OBITUARY.

Lord Kelvin, P.C., O.M., G.C.V.O., D.C.L., LL.D., D.Sc., F.R.S.—On the 17th inst., Lord Kelvin, one of the last of the great men who were the leaders of science in the nineteenth century,

died at his Scottish residence, at Largs. William Thomson was born on June 26th, 1824, the second son of James Thomson, Professor of Mathematics in the University of Glasgow. He began to attend classes at Glasgow at the age of eleven. At Cambridge, he graduated as Second Wrangler and first Smith's Prizeman in 1845. He was a Fellow of Peterhouse from 1846 to 1852, and he was re-elected in 1872. After spending a short time in Regnault's Laboratory, in Paris, he was appointed Professor of Natural Philosophy in the University of Glasgow, which office he held until 1896. His first scientific paper was published in the Cambridge *Mathematical Journal* in 1841. It was "On Fourier's Expansions of Functions in Trigonometrical Series."

It is scarcely possible here even to allude to the enormous amount of Lord Kelvin's scientific work. In the obituary in *The Times*, this is described, under the headings—Atomic Theory, Thermo dynamics, Age of the Earth, Inventions, Ocean Telegraphy, Measurement, Navigational Apparatus; and in all these researches he exhibited a brilliant example of an intimate union of the life of action with that of the student. During Lord Kelvin's life, honours were widely bestowed upon him. He was four times President of the Royal Society of Edinburgh, President of the British Association, at Edinburgh in 1871, and President of the Royal Society from 1890 to 1895. He was as greatly honoured abroad as at home. He was a Foreign Member of the Institute of France, a Grand Officer of the Legion of Honour, and a Knight of the Prussian Order, "pour le Mérite."

He was elected a member of the Society of Arts in 1880 and took a great interest in its work. He held the office of Vice-President from 1893 to 1896, and from 1903 to the time of his death. On March 2, 1881, he read a paper before the Society on "Lighthouse Characteristics." The "Albert medal" of the Society of Arts was awarded to him in 1879, and presented to him by H.M. the King (then Prince of Wales and President). In 1892 the great name of Sir William Thomson was lost in what has become the equally great name of Lord Kelvin. In 1896, on the occasion of the celebration of the fifteenth anniversary of Lord Kelvin's tenure of the Professorship of Natural Philosophy at the University of Glasgow, the Council of the Society of Arts appointed the late Sir Frederick Abel to act as their representative and to present to him a congratulatory address.

From 1904 until his death, Lord Kelvin was Chancellor of the University of Glasgow, which he served for so long a period. The crowning honour was his burial on Monday, 23rd inst., in Westminster Abbey, where were gathered a large company of mourners containing representatives of the many institutions with which he was connected. His last resting place is appropriately close to the monument of Newton.

John Sparkes.—Mr. John Sparkes, R.I., the well-known art teacher, died lately at the age of 74. He was a member of the Society of Arts from the year 1874, and a frequent attendant at its meetings, joining in the discussions, and taking the chair on several occasions. He read a paper on "Lambeth stoneware" in 1874, and another in 1880 on "The future development of the Fine Art Section of the Lambeth Pottery," for which paper he received the Society's silver medal. He was himself first taught by Paul Naftel in Guernsey, and afterwards studied at Leigh's and at the Academy schools. About 1853 he entered the newly-founded Art Masters' Training Class in the Government School at Marlborough House. A year later he took charge of the art classes formed by the Rev. Robert Gregory—the present Dean of St. Paul's—at the schools of St. Mary-the-Less, Lambeth; and from these classes he soon developed the very successful Lambeth School, which presently attracted students from all over the country, and even from abroad. At Lambeth he formed a friendship with the late Sir Henry Doulton, and the well-known "Doulton ware" owed much to Mr. Sparkes's designs. In 1875 Mr. Poynter (now Sir E. J. Poynter, P.R.A.) became Director of the Government Art Schools at South Kensington, and at his invitation Mr. Sparkes accepted the post of head of the teaching staff, which he retained till 1898, when he retired, having reached the age limit.

SYLLABUS OF THE JUVENILE LECTURES.

F. Martin Duncan, "The Scientific Applications of the Cinematograph." Two Lectures.

Lecture I.—January 1.—The Cinematograph as a popular instructor—A note on persistence of vision —How the spinning of a shilling was responsible for the invention of Cinematography—Early workers in the field — Muybridge — Marey — Anschutz — The Thaumatrope—Wheel of Life—Zoetrope—Choreutoscope—Book form apparatus—The modern Cinematograph really the result of the invention of Celluloid—The application of the Cinematograph to Microscopy.

Lecture II. — January 8. — The Scientific Applications of the Cinematograph—Its application to the study of Insect Life—To Animal Life—To Plant Life—To the study of the races of mankind —The future of the Cinematograph.

Each Lecture will be profusely illustrated by ordinary lantern slides, slides by the Autochrome Natural Colour Photography, and by Animated Pictures.

Journal of the Society of Arts.

No. 2,876. VOL. LVI.

FRIDAY, JANUARY 3, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 8, 5 p.m. (Juvenile Lecture.) F. MARTIN DUNCAN, "The Scientific Applications of the Cinematograph." (Lecture II.)

Further details of the Society's meetings will be found at the end of this number.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

JUVENILE LECTURES.

On Wednesday afternoon, January 1st, Mr. F. Martin Duncan delivered the first lecture of his course, addressed to a juvenile audience, on "The Scientific Applications of the Cinematograph."

Abstract.

Long before the invention of photography the idea of the animated pictures might have been conceived and put into practice. Possibly soon after man had first learned how to make fire and keep it alight, and to shelter himself between four walls, the first primitive animated picture show was given.

Passing from the shadow pictures formed by primitive man upon the wall of his hut we may enter the dining-room of a great philosopher one evening in the early years of the nineteenth century (1826) and witness the next stage towards the modern animated picture.

Dessert has been served, and Sir John Herschel seated at the table with his friend, Charles Babbage, is idly spinning a pear. He suddenly turns to his friend and asks how he would show both sides of a shilling at once. Babbage replies by taking a shilling from his pocket, and holding it up in front of a looking-glass. This method does not satisfy Herschel, who has thought of a better, and who now taking the shilling sets it spinning upon the table, at the same time pointing out that if the eye is placed on a level with the rotating coin, both sides can be seen at once.

In this simple after-dinner experiment, we see the birth of that idea from which every form of the modern animated picture has its origin. Babbage was so struck with Sir John Herschel's demonstration, that the next day he described it to his friend Dr. Fitton, who at once made a working model. This model consisted of a round disc of card suspended between two pieces of sewing silk. On one side of the card disc was drawn a bird; upon the other an empty birdcage. On the silk thread being held between the finger and thumb of each hand and made to turn quickly, the disc of card revolved, and the bird appeared to have got inside the cage.

This model showed what is called "persistence of vision," upon which all animated

pictures depend for their effect. What is meant by persistence of vision, is that the eye retains an impression of the object looked at for a fraction of a second after the object has been removed, and therefore the spinning of the disc brings the two pictures so rapidly one after the other before the eye, that they appear to mingle and make one picture.

It is rather startling to read of the Royal Institution as a toy shop, but Babbage relates how a few months after the production of the Herschel-Fitton disc, he purchased a similar toy at the Royal Institution for the sum of seven shillings and sixpence. The toy was then called a thaumatrope, and incorrectly stated to be the invention of Dr. Paris.

After the production of the thaumatrope, the next important step was the invention of the zoetrope, or "wheel of life," somewhere about 1833-34 by W. G. Horner, who described it in the pages of the *Philosophical Magazine*, but apparently did not trouble to patent it. In 1867, however, an American obtained a patent in the States for identically the same machine. The zoetrope was a cylindrical apparatus enabling more than one person at a time to view the moving figures. The cylinder was perforated by a series of slots, and within the cylinder was placed a band of drawings of dancing men. On the apparatus being slowly rotated, the figures seen through the slots appeared to be in motion. This zoetrope was gradually modified, and when the advances in photography had made it possible by means of the camera to take serial photographs of objects in rapid motion, these photographs were used in place of the drawings.

The first systematic photographs taken at regular intervals of men and animals were made by Muybridge in 1877-78.

Muybridge made a horse run along a track in front of a row of from twelve to thirty cameras, the shutters of which were opened and closed by electric means. The horse moved in front of a white, brilliantly lighted wall, so that its figure appeared as a silhouette, and it was really the white wall that was photographed. Mr. Muybridge described the methods adopted by him, in a lecture delivered in this room on April 4th, 1882.

In 1883, Muybridge again took up the study of the movements of men and animals, and used forty automatic cameras; men and women were photographed going on the flat, up hill and down hill, walking, running, jumping, &c. All Muybridge's pictures were taken in a large size, but Anschutz used small cameras, fitted with a lens of 2½ inch diameters and 10 inch focus, at a distance of twenty to forty metres. He began in October, 1885, to take connected pictures of men and animals, using from eighteen to twenty-four cameras.

Marey, of Paris, in 1883, founded a studio for taking serial photographs of men and animals, and called his work, chronophotography. A slide shows the studio or track around which, at intervals of fifty metres, were telegraph poles, from which signals were sent to the principal stations, so that the rate of movement could be calculated. Marey clothed his subjects in white, and used a black background, and also only used one camera and one lens, several exposures on one plate.

His apparatus is shown on the screen. It was a dark room running on rails, so that various-sized images could be obtained. Outside was a rotating disc with apertures cut in it, through which the light passed, thence through the lens to the plate.

In order to determine whether the figures were taken at regular intervals, there was on the dark back-ground a circle of black velvet with a bright finger, and white nails around the edge of the circle. The pointer was made to travel at a given speed around the circle by clockwork, and the intervals between each exposure were determined by the angles of the pointer.

Later, in 1890, Marey used a camera fitted with roll films, which were unrolled from a spool, and remained stationary for the moment of exposure. This was practically the first form of the present-day cinematographic camera, and it was really the invention of celluloid that made it possible to obtain the long rolls of pictures that are used to-day.

So we see how, from that simple experiment of spinning a shilling, little by little, and step by step, the animated picture was gradually evolved, until to-day we are able by the aid of the cinematograph to see on the screen perfect representations of moving objects.

And now let us consider to what use we can put the result of all the thought and labour that has been expended in perfecting cinematography.

By the aid of cinematography we shall be able to see, and learn about, all sorts of useful and interesting things.

The lecturer was the first to apply the cinematograph successfully to natural history subjects, and he assured the audience that it had been most delightful, and often exciting work, watching and photographing

the habits of the birds, animals, insects, and fishes. It had also been his good fortune to combine successfully the cinematograph and the microscope, so that he was able to show some of the marvels of that wonderful fairylike world, unseen, yet playing such an important part in the life and well-being of mankind. With the aid of the cinematograph and microscope he had obtained records of the circulation of the blood, the rotation of protoplasm in the vegetable cell, the movements of living bacteria, and many other wonders to be seen through the microscope.

The second lecture will be delivered on Wednesday next, 8th inst., at 5 p.m.

CANTOR LECTURES.

THE THEORY OF THE MICROSCOPE.

By Conrad Beck, F.R.M.S.

Lecture II.—Delivered November 29, 1907.

The Error of Lenses and their Correction.

Syllabus.—Bad quality of images formed by simple lenses—Chromatic aberration: its cause—Method of correction of chromatic errors—Apochromatic correction—Spherical aberration: its cause and method of correction—Zonal aberration—The Sine condition—Gauss planes become spherical surfaces for correction of the Sine condition—Tangent condition: its incompatibility with Sine condition—Colour correction to give equal magnifying power for different colours—Summary of microscope correction—The peculiar method by which the Huygenian eyepiece is corrected.

In the previous lecture it was shown how a lens produces an image of an object, also how by suitable arrangements of lenses an efficient method has been developed of producing a highly-magnified image of an object. This lecture will be devoted to the consideration of the optical quality of such an image. An efficient microscope must not only produce a magnified image of an object, but that image must be a clear and well-defined picture, otherwise it will probably not reveal any structure that could not be seen by the naked eye. Even a cursory examination of the image produced by a simple uncorrected lens demonstrates that the picture which it forms is far from perfect. It has fuzzy outlines and coloured fringes, and that portion which is formed by the light which passes through the lens in an oblique direction shows still more series defects. The most satisfactory method of investigating the quality of an optical image is to simplify the problem by using a pinhole as an object and to examine the picture which is formed by the lens of this single minute point of light. Every object consists of a mass of points in juxtaposition, and an apparatus that is capable of producing a point image of a point source of light placed in succession in the various positions occupied by the object will produce a well-defined and clear picture of that object.

When a point of light is depicted by a lens as a fuzzy disc, then a line, which consists of a row of points, will be depicted as a series of fuzzy discs overlapping each other, and the outline of a sharp edge will appear as in Fig. 22 (lower edge of lower line), to be indistinct and hazy. If all points, except three, are sharply depicted the image will appear as

Fig. 22.

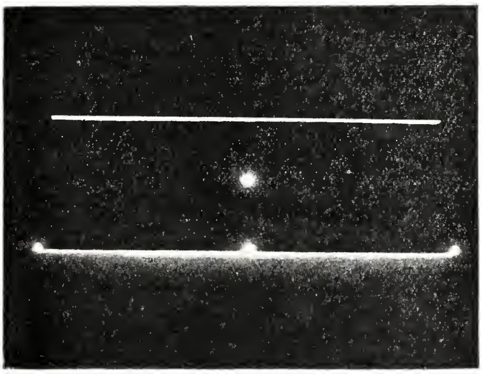


Fig. 22 (upper edge of lower line), while if every point in the object is depicted as a point, a clear outline as in Fig. 22 (upper line) will be formed.

Microscope lenses must be unusually perfect in their image-forming qualities, because the images which they produce are highly magnified, and any imperfections will also be highly magnified.

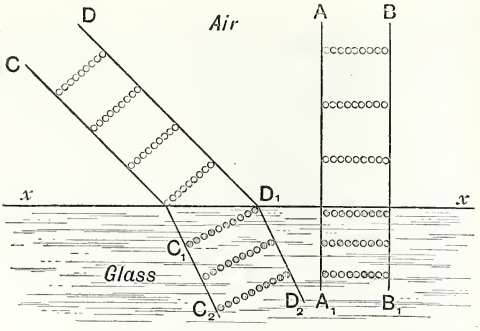
No matter how well constructed a single lens may be, it possesses numerous defects, defects which are due to different causes and are remedied by different means, and it is well to treat them separately. We will commence with the chromatic error, and then consider the chief spherical aberrations; proceeding to discuss later some of the less obvious, but equally important defects.

Until the early part of the nineteenth century no means was known of correcting the defects of a single lens, and the microscope

was restricted in consequence to the use of comparatively low magnifying power.

The properties of a lens depend upon the fact that it is made of a dense material, such as glass, which retards the rate of speed at which the light travels as it passes through it. A beam of light (Fig. 23, A B) striking a glass surface at right angles to the surface passes into the glass, and is reduced in its speed of travel, but is not altered in its direction. If a beam strikes the surface obliquely, as at C D, the portion C strikes the glass first, and is retarded before the portion D has reached the surface; so that it has only gone as far as C_1 by the time the portion D has reached D_1. After this, the two portions both travel at the reduced rate of speed, but the direction has been changed at the surface of the glass, and the light is said to be refracted.

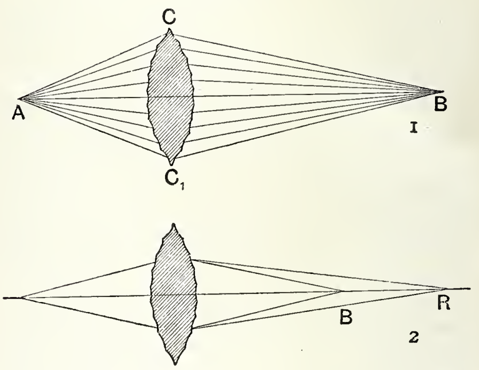
FIG. 23.



Light is a vibration, a movement of particles of a hypothetical material called ether, just as sound is a vibration of the particles of air, but white light is not a single vibration, similar to a single musical note or sound, but a complete octave travelling together. If it be dissected into its various components or individual notes it is found to consist of a series of vibrations, each of which has a different period, and each of which produces upon the eye the effect of a different colour. The reason why glass retards the motion of light, is that vibrations cannot take place so easily in the denser material, and it is therefore readily understood that the different colours, each vibrating at a different rate, are not affected to the same extent, and thus glass retards the short wavelength colours such as violet and blue to a greater extent than the longer red and yellow vibrations, and the violet and blue light is bent or refracted to a greater extent. A beam of white light refracted or bent by a prism shows for this reason a coloured spectrum because the light of each colour being refracted to a different extent occupies a different position after it has passed through the prism. A lens when it bends the light which passes through it acts in the same way as a prism upon the different colours. Suppose A, Fig. 24, to be a point radiating light in all directions, all the light that can pass through it to the further side of the lens CC, is included in the cone ACC, and in order to produce a perfect picture of a point A by means of a lens, it is necessary that every one of the rays of light which emerges from A shall pass through a point B.

If the shape of the lens be such that every portion of its surface is arranged in little facets, each facet being so placed as to bend the ray of light which strikes it in the correct manner, this could be achieved for one coloured light but as different coloured light is refracted differently it cannot be done with any single lens for all

FIG. 24.



colours, and the blue light will be refracted to a point at B, Fig. 24 (2) while the red is focussed to a point at R, thus the focal length or refracting power of a lens is different for different coloured light. A screen placed at R will show a red centre surrounded by blue coloured edges, a screen placed at B will show a blue centre surrounded with red edges.

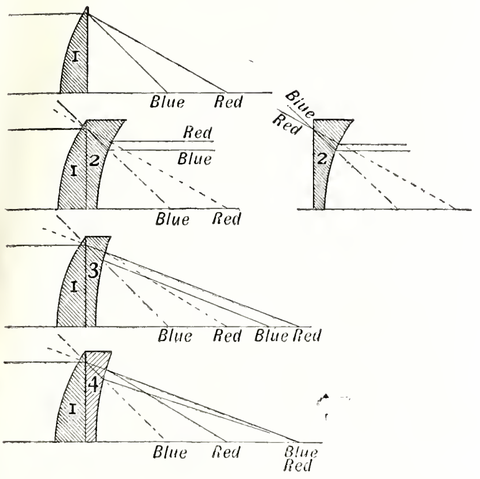
That is the chromatic defect possessed by a simple lens called chromatic aberration, and its correction is called achromatism.

Achromatic correction is possible, because the optical properties of glass can be varied according to the materials used in its manufacture. Two kinds of glass can be made, one of which has a greater effect on different coloured rays, what is called greater dispersion, than the other, but has the same average refraction.

Suppose two lenses (Fig. 25), 1 and 2, which are of the same focus, are composed of the same kind of glass, it is evident that the

errors of 1 exactly neutralise the errors of the other, 2, because 1 is positive and 2 is negative, and one is the exact converse of the other, but the lens 1 neutralises the lens 2 in every other way, and a plane piece of glass

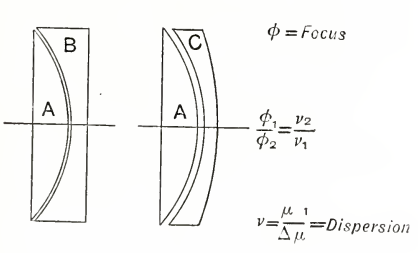
FIG. 25.



having no lenticular qualities is produced. If a negative lens be made of a lower power, as at 3, a partial neutralisation of the colour error takes place, but only to the same extent as the neutralisation of the lenticular action, and thus no correction is obtained, the lens might just as well be of solid glass. If, however, the negative lens, as at 4, is made of a glass which has greater effect on the blue rays than lens 3, and the same effect on the red rays, then a combination can be obtained to correct the colour error.

If, as shown in Fig. 26, two lenses, A and B, are of the same focus, and made of the same

FIG. 26.

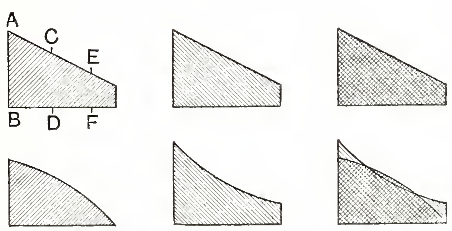


glass, they neutralise each other, both as to their errors and every other characteristic, but if the negative lens, C, is made of a glass that has double the dispersion or effect upon the colour, it needs only half the power to correct the colour error, and the lens, A, is only partially neutralised by C, the combined pair still having the properties of a lens, although reduced in power. Therefore, to correct the central colour aberrations of a thin positive single lens, all that is required is to combine with it a negative lens of greater dispersion, making their foci in the exact ratio of the dispersion of the glasses, of which they are made.

$$\frac{\phi_1}{\phi_2} = \frac{\nu_2}{\nu_1} \quad \phi = \text{Focal length.} \quad \nu = \frac{\mu}{\Delta\mu} = \text{dispersion.}$$

This simple formula for the correction of achromatism is easily remembered, and it should be particularly noted that it only involves that the focal lengths of the two lenses of the combined pair should be in a definite ratio, and does not put any further limit to the shapes or curves of the lenses. It only applies in this simple form to thin lenses in contact, and it is a somewhat more complex formula when very thick lenses are used, or when the lenses are placed at a considerable distance apart. It has a further limitation due to

FIG. 27.



another property of glass, which may be illustrated by a diagram (Fig. 27). Suppose the colour aberration of a single positive lens be illustrated by the height of the line, A B for one colour, C D for another colour, and E F for a third, and suppose the aberration of a similar focus negative lens, with double the dispersion, is represented by the diagram to the right of this, when the two diagrams are super-imposed as shown to the extreme right, they extinguish the aberration, but this is because the action of the glass has been in both cases regular and has affected every colour relatively to the same extent. Unfortunately the action of glass is irregular and is more nearly represented by the curved lines of the lower diagram, and when the two lower diagrams are super-imposed it will be observed that at no position can the aberration be entirely cured. Any two points can be exactly corrected, but a small residuum of colour called the secondary spectrum is left. Lenses corrected in this manner are called achromatic.

When more than two kinds of glass are used to make the chromatic correction, three colours can be exactly corrected and the amount of colour then visible in an image formed by them is so small as to be negligible.

Lenses corrected in this way are called apochromatic, the advantage of microscope apochromatic lenses would, however, be very slight if they possessed no other quality than this slightly improved colour correction, which is of more importance in the correction of astronomical telescope object-glasses. The slight residuum of the secondary spectrum is seldom of sufficient intensity compared with the whole quantity of light to impair seriously the quality of the picture.

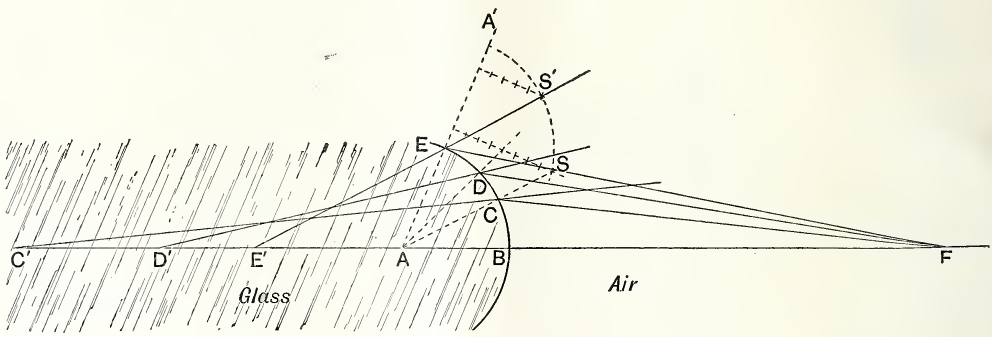
The next error in a simple lens, called spherical aberration, is a consequence of the practical fact that spherical curves are the only surfaces that can be accurately ground on lenses. The cup and ball motion is the only known method of grinding and polishing a true optical surface. This motion enables the whole of a surface to be ground evenly. Any other surface as, for instance, a parabolic surface cannot be ground, the process of grinding would take place irregularly because unless the rubbing and grinding action can take place in more than one direction, the surface will be ground unevenly at different parts, and it is evident that two parabolic surfaces cannot be moved upon one another while remaining in contact except by revolution on one axis. Thus all lenses if they are to have perfect surfaces must be spherical in shape.

Now referring back to Fig. 24, we notice that a lens with surfaces that consist of a series of minute facets will accurately focus light from a point, so that it is refracted to another point, and if we make these facets sufficiently small and sufficiently numerous the surfaces become curves; but unfortunately these curves do not prove to be spherical surfaces.

The next diagram will explain the defect of a spherical surface. The refraction of light follows a definite law, expressed by the equation $\frac{\text{sine } i}{\sin r} = \mu$, namely that the sine of the angle of incidence is in a constant ratio to the sine of the angle of refraction. This constant depends on the nature of the glass employed, and is called the refractive index of that glass, and the diagram is so constructed that the moving lines which represent the incident and refracted rays obey this law of refraction.

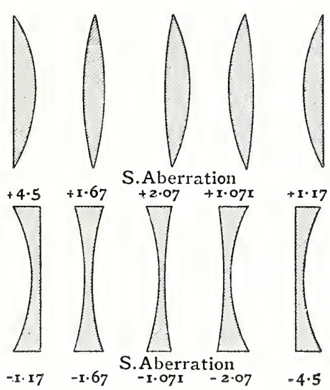
A spherical surface with a centre A is represented by the line B C D E, and a ray of light is incident on the surface from a point F on the axis. The diagram is so arranged that the ray from F can be moved so as to strike the surface at any point, as for instance, at C D or E, and that a line C C′, D D′, E E′ is automatically placed in the correct position, so that the sine of the angle made by this line with the perpendicular to the surface at the point where it cuts is in the ratio of two-thirds of the sine of the angle of incidence, thus the lines E E′, D D′, C C′ correctly represent the refracted rays which correspond to the incident rays F E, F D, F C, &c. That this is so may be seen by noting the positions of the points S and S′ on the scale of divisions which is ruled parallel to the normal to the spherical surface. The distance of S from the normal A A′ is the sine of the angle of incidence, while the distance of S′ from the normal A A′ is the sine of the angle of refraction, and it will be noticed that, as the diagram is moved, these distances always retain the constant ratio of 3 to 2, and the diagram is therefore a correct representation of what happens with refraction at a spherical surface of glass having a

Fig. 28.



refractive index of 1·5. The diagram being thus proved to be an accurate representation of refraction at a spherical surface, we may investigate the properties of such a refracting surface. The light which passes through the surface at a position close to the axis at C comes to a focus at C′; that which passes through further away at D, comes to a different focus at D′; while further away still it focusses at E′, showing that the whole of the light coming from a point is not brought to a focus at another point, and there is no position where a sharp image can be obtained. If a screen be placed at any position between E′ and C′, the point object will be represented by a fuzzy disc of light instead of a point. This error is not very marked in light at a small angle from

FIG. 29.



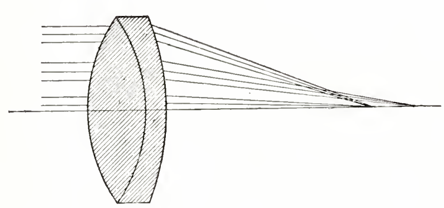
the axis, but rapidly increases as a large angle of light from the object is refracted by the surface. It will be seen subsequently that one of the essential requirements of a high-power microscope object-glass, is that it should collect a very large angle of light from every point of the object, and consequently the correction of this error is a matter requiring more attention than any other in microscope construction.

If two spherical surfaces forming a lens be used, this defect will exist at each surface. In certain shapes of lenses the two surfaces acting in the same manner exaggerate the defect. In other shapes they balance each other to some extent, but no single lens of two surfaces can be made even approximately free from the defect with any known refracting medium.

Thus the shape of a lens has a great effect on the amount of spherical aberration. The diagram (Fig. 29) shows a series of lenses all of the same focus, but of different shapes, and having consequently very different amounts of spherical aberration. The same method of correction may be adopted, as in achromatism, of making a powerful positive lens and partially neutralising it with a negative lens, which, although it has a lower power, has greater relative aberration, due to its different shape, and thus neutralises the error of the more powerful positive lens.

The method of correcting achromatism is by making the foci of a positive and negative lens in a certain definite ratio, but the lenses may be of any shape. The method of correcting spherical aberration is by making the shapes of the lenses of suitable form, thus it is possible simultaneously to correct these two errors by a pair of thin lenses placed close together, the colour correction being in no way antagonistic to the correction of the spherical aberration. But as with achromatism so with spherical aberration, complete

FIG. 30.



correction is only obtained with very great difficulty.

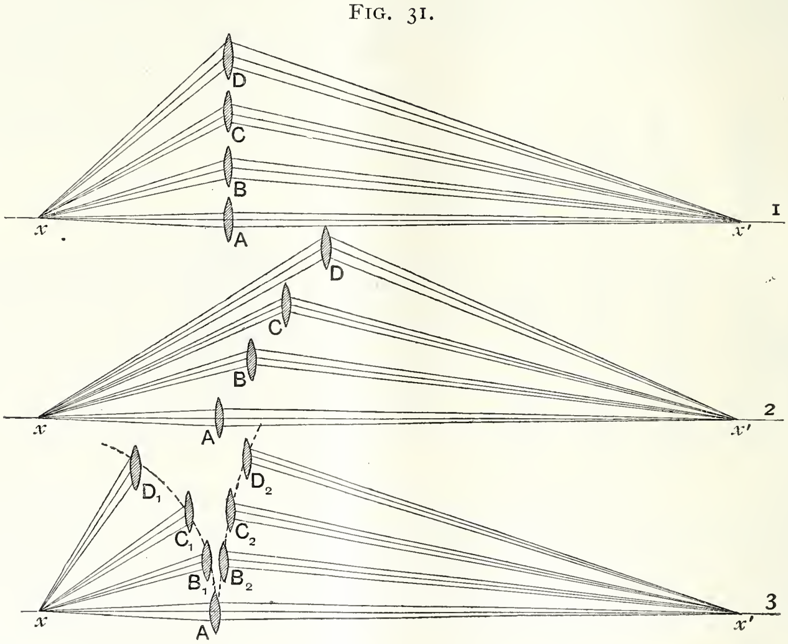
When the central rays are brought to the same point on the axis as those of the edge it does not at all follow that the intermediate zone of the lens is also focussing the light to that point (Fig. 30); a residual so-called zonal aberration remains, which, in the case of the microscope, is one of the most serious difficulties to be overcome, because the aperture of a microscope object-glass is so large compared with its short focus. The full correction is obtained by using more than two lenses with suitable shapes, five, six, and even ten lenses being sometimes required, but the entire correction of the spherical aberration error, being a question of elaborate arrangement of the shapes and distances apart, cannot be followed in detail.

The means of correcting a lens system so that all light coming from one point on the axis shall be refracted to another exact point on the axis has been now considered. Let us suppose that by the methods explained we have eliminated the central colour aberration and the central spherical aberration from a

lens combination. It might be expected that for small areas close to the axis such a lens system would produce reasonably perfect images. This is, however, by no means necessarily the case, and the next diagram (Fig. 31) will illustrate the way in which a lens system may give a perfect image of a point which is exactly upon the axis, but a very bad image of a point which is even to the slightest extent away from the axis.

Suppose that a lens that is corrected for central spherical aberration is split up into several portions A, B, C, D, one for each zone of the lens, and that each portion is represented by a separate small lens, it is evident that there are many ways of so compounding a series of small lenses that all the light from X will arrive at X'. Fig. 31 (1) shows a method in which all the lenses are above one another. Fig. 31 (2) shows a method in whch the lens D is someway to the right of lens A. Both these arrangements may be made to give a perfect correction for central spherical aberration, but it is evident that in the arrangement in Fig. 31 (1) the lens D must have a longer focus than the lens A, as the distance D X is longer than the distance A X but to only a slight extent, whilst in the second arrangement the lens D must be of much longer focus than the lens A. The central spherical aberration is corrected in both these figures, but by different methods, and we should not expect to find exactly the same results produced. The difference in the two methods will be evident when we remember that the size of an image formed by a lens depends upon its focal power, and therefore in Fig. 31 (2) the image of the object formed by the lens D will be much larger than the image formed by the lens A, in fact, almost twice the size. The effect of this will be confusion in the picture, a number of images of different sizes overlapping one another. The exact point in the centre may be correct, but the slightest fraction away from the axis, and all is fuzzy and indistinct. There is not even a small area where a good image will be formed, but only one exact point. The case illustrated in Fig. 31 (1) is much better in this respect, because the lens D is not much longer in focus than the lens A, but the defect exists even there.

Fig. 31.



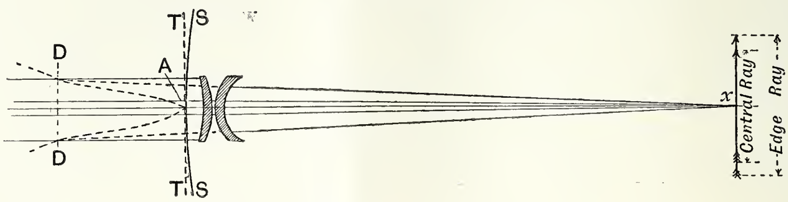
To produce even a small image of good quality, each of the lenses, A, B, C, D, must have the same focal length, so that each will give the same size image, and if this is so, each lens must be placed at the same distance from X, as shown at Fig. 31 (3), so that the distances, A X, B_1 X, C_1 X, D_1 X, are all equal; in fact, the refraction must all take place as from a circular line, with its centre at X, but it will be observed that for this purpose to be attained the lenses should also be placed at A, B_2, C_2, D_2 Fig. 31 (3), on a circle, with the point X' as its centre, in order that they may also be at equal distances from the image X', because, as seen in the first lecture, the relative size of object

and image depends on their relative distances from the lens. Suppose an optical system of lenses to be made which has the properties which satisfy the Gauss plane condition, in which the light behaved as though at the point D_1 (Fig. 31, 3), there was an equivalent lens to receive the light, which jumped to D_2 to discharge it, and suppose at C_1 and B_1 the light behaved as though the equivalent lens jumped to the positions C_2 and B_2. This optical system would fulfil the condition that is required to give perfect image formation for a small area of the centre of the picture, namely, all the rays would form images of the same size. In fact, to make a perfect image-forming apparatus of this nature, the equivalent planes of Gauss must be made spherical surfaces, with the object and image as their centres. It will be observed that a property possessed by rays of light which are refracted by such a system, is that the sines of their incident and refracted angles with the axis, are equal to a constant quantity, and that constant quantity is the magnifying power of the system, because it represents the relative distances of object and image $\frac{\sin i}{\sin e} = \frac{A\ X'}{A\ X.}$ Thus this condition which has to be complied with in order to form a perfect image at the centre of the picture, is generally called the "sine condition." This condition was first proved theoretically by Helmholtz, by photometry, and by Abbe, by Fermat's least time principle (I am demonstrating it here, by a simple geometrical proof), but before this, Frauenhofer had shown the necessity of it for constructing telescope object - glasses, and Lister had shown, in 1830, the means of arriving at this important correction in the manufacture of microscope object-glasses. He called the defect which arises when it is not corrected, coma, a term which, strictly speaking, describes the defect, although it is now more generally applied to a similar defect at the edge of the picture. For twenty years after the date when Lister, improving upon the purely haphazard methods of Chevalier and Amici, had shown how aplanatic microscope object-glasses could be made, the Lister formula lenses were considered the best in the world, and this was due to the fact that by the elimination of the comet form tails known by the name of coma, which existed in images of points of light which were pictured near to, but not absolutely, in the centre of the field, the so-called sine condition was satisfied. Too little attention has been given by recent writers to the work of Lister. He discovered the two spherically correct foci of a lens, one of which was over and the other under-corrected for the sine condition, and showed how, by making use of the over-corrected focus of one lens with the under-corrected focus of the second lens, coma could be eliminated.

This explains the third important correction that has to be made in microscope object-glasses, namely, the sine condition. If a large picture is required, if for instance, a photograph is to be taken to include a view that subtends, say 60 degrees, it can be shown that the optical instrument, to project such a picture without distortion and with good definition at the edge of the field, must be made so that it fulfils the condition of the Gauss equivalent planes, and that those planes must be flat and not spherical surfaces. In this case the angles of the incident and their refracted rays with the axis are in the ratios of their tangents, and not of their sines. Thus it would appear that if a picture is to be absolutely sharp in the centre, it will not be absolutely sharp and free from distortion at the edges, and this is the case; but the difference between the sine and the tangent is a negligible quantity for small angles, and, therefore, if moderate cones of light from each point of the object are used, the two conditions can be simultaneously satisfied. This is the case with photographic lenses, the half cones of light received from each point of the object being seldom more than five or six degrees. High power microscope lenses, however, often admit cones with a semi-aperture of 75 degrees, and the sine condition must be satisfied in order that perfect central definition may be obtained. This is imperative, because the great magnifying power makes the absolute perfection of the image a necessity, consequently the definition at the extreme edge of the field of a high-power object-glass is somewhat sacrificed for the benefit of central definition. It is, however, interesting to observe that when the tangent condition of the flat equivalent planes is satisfied, instead of the sine condition with the spherical equivalent planes, the result in the centre of the field is not far from correct, and is far superior to that which is frequently obtained with lenses which, though corrected for central spherical aberration, are not corrected for either the sine or tangent condition. Fig. 32 shows a lens which is corrected for the chromatic aberration and for central spherical aberration, but the central ray emerging from A to X' is met by an edge ray emerging from

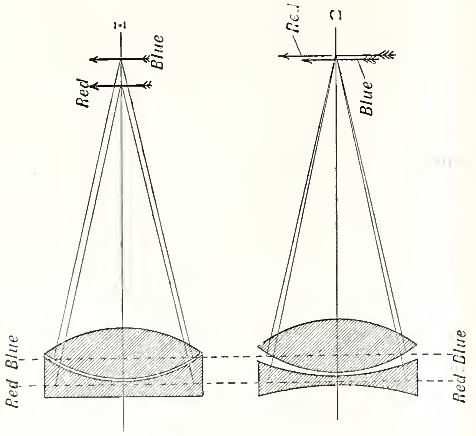
D to X′. The latter marginal rays will evidently give a great deal larger image of the object than the central, and the fuzziness of the picture, even close to the centre of the field, will be marked. The Gauss surface of this lens may be considered as a curve drawn through A and D, whereas if the tangent condition had been satisfied it would be a plane T T, and if the sine condition had been satisfied it would be a spherical surface S S, showing that there are many worse things in an optical instrument than to have the tangent condition satisfied.

FIG. 32.



The colour correction must also be investigated from this same point of view. The method of making a corrected lens in such a way that different coloured light from a point on the axis will converge to another point has been explained, but will the sizes of the different coloured pictures formed by such a lens be equal and therefore be exactly superimposed, or will they be different and overlapped because, if the latter is the case, the same error will exist that, except for the exact centre, there will be coloured fringes which spoil the definition of the picture. Fig. 33 (1) shows a pair of lenses whose focal lengths are in the same ratio as the dispersion of the two glasses, and consequently all coloured light has the same focal length. It is corrected in the manner previously described, but the equivalent planes for different coloured light are not in the same position and, therefore, although all coloured light has the same focal length, it does not meet at one point on the axis. In Fig. 33 (2) the foci of the lenses have been slightly changed, so that all the light meets at a point on the axis; but in this case the focal length of different colours is different, and the sizes of the different coloured images will not be the same. It is therefore evident that for good colour correction something more than equality in focal length is necessary; the position of the different equivalent planes must also be the same. In the last lecture we saw that the position of the equivalent planes was influenced very largely by the shapes of the lenses, and thus, in order to make a perfect colour correction, the lenses, in addition to having their foci in the correct ratio according to the dispersion of the glass, must also have particular shapes so that the equivalent planes of the compound lens may be the same for all colours.

FIG. 33.



We have now glanced at the most important corrections which must be made in order to construct a good microscope object-glass. Time will not allow of the consideration of some of the minor points, and it must not be supposed that the question of optical corrections in general has been adequately outlined in the above remarks. Other corrections are necessary in optical instruments which deal with pictures formed by oblique beams of light, but the microscope is confined to producing the most perfect possible pictures by means of wide angle bundles of rays in a small field of view. Oblique corrections therefore need not detain us, it has already been shown that they cannot be entirely satisfied at the same time as the central, and with the microscope the perfection of the central part of the image is of such importance that nothing must be attempted that will prevent the realisation of this to the fullest degree. The above errors, and their method of correction, may be summarised:—

1. Equal Chromatic Focal Length. Correction—Ratio of foci of component lenses.

2. Identical Position of Chromatic Gauss planes or surfaces. Correction—Shapes of component lenses.

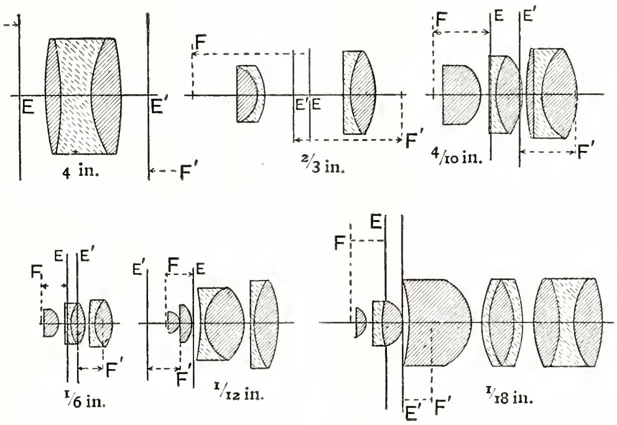
3. Central Spherical Aberration. Correc. tion—Shapes of component lenses and their distances apart.

4. Spherical Gauss Surfaces, sine condition. Correction—Shapes of component lenses and their distances apart.

5. Zonal Aberration. Correction—Shapes of component lenses and their distances apart.

Now, if there were only one method of correcting each of these errors, it would be impossible to correct all at one time, but as there are several methods of correcting each defect, faction of this condition immediately fixes the relative focal lengths of the component lenses. This, however, is not quite as fixed a matter as has been stated, because the thickness of the lenses and their distances apart has considerable influence, and a second method of solving the problem can be found when thick lenses at different distances are used; thus there are two methods of making this correction. The other four corrections are all dependent on the shapes of the lenses, whilst their foci, or their foci thickness and separation combined, are kept at the correct ratio for satisfying the condition No. 1. The number of methods of making these corrections is quite unlimited, depending upon the number of lenses employed to make the complete object-glass. The larger the

FIG. 34.



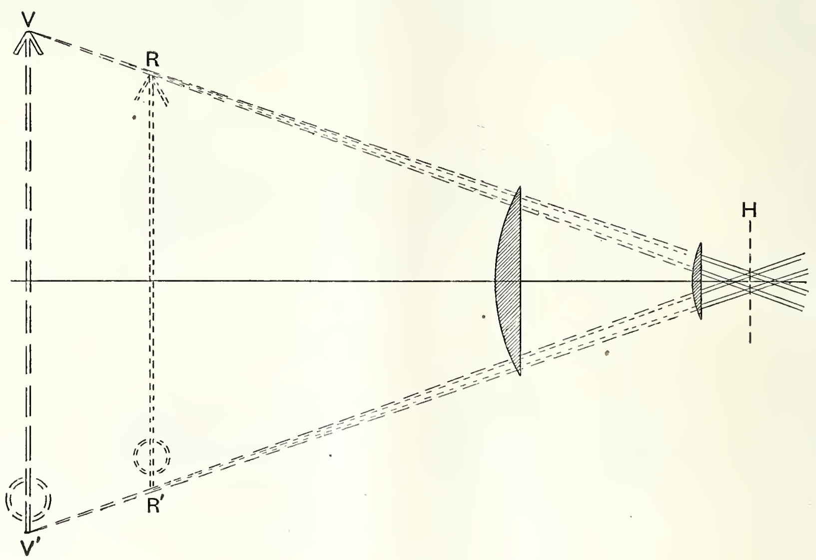
the problem of correcting them all in one system of lenses is rendered possible. Suppose one desired to have some one object from which one could cut slices to illustrate the shape of a circle, a triangle, an ellipse and parabola. If a circle could be only cut from a ball, and an ellipse from an egg, and so on, no one object would provide the necessary slices, but a circle can be produced in several ways by a section of a ball, a cylinder, an ellipsoid, a parabola, and for this reason an object can be found that will produce all the above shapes. Thus slices, all cut from a cone, will give a circle, a triangle, an ellipse, and a parabola. In the same way, the task of correcting a lens system for five different errors is made possible, because there are several methods by means of which each individual defect may be cured. The correction No. 1 for equal chromatic focal lengths is the one that has the fewest methods of solving, as it has been seen that the satis- number of lenses the greater is the possibility of making different combinations of correct shapes; thus, for the correction of each defect that method may be selected which is not antagonistic to the correction of all the other errors. It is advisable to make the lenses as few as possible, because each extra lens introduces chances of error in manufacture and stops light by absorption and reflection. It is evident that the corrections must be much more perfect as soon as high magnifying power is used, and are much more difficult when large angle bundles of light are admitted from each point of the object. It will be shown in the next lecture that it is necessary with high magnifying power to admit wide angle pencils of light, and thus although low power lenses can be made with a few components, high power lenses must be constructed of a number. The above diagram, Fig. 34, displays a typical series of object-glasses, ranging from a 3 inch to an 1-18 inch, the low powers having from 3 to 4

lenses while the higher powers have from 6 to 10 components. The best achromatic 1-12th oil immersion object-glasses of about 1·3 N.A. have generally six lenses, and that is the smallest number with which a perfect object-glass with so large an angle has at present been made. I say at present because recent advances in photographic optics have shown such unexpected results attendant upon the use of separated lenses that it would be a mistake to assume that there are not similar possibilities in microscopic optics. We hear much nowadays of the superiority of foreign nations in optical invention that it may be worth recalling the fact that Lister was the first to show how to correct the sine condition in the microscope object-glass, and Dennis Taylor was the first to show the method of making full use of separated lenses in the photographic objective. The self-depreciation of Englishmen as to the work of their own countrymen has no sufficient justification in the realms of optical instrument making. The two instances above cited show originality which has received far more appreciation in foreign countries than at home.

In the author's opinion there is a chance of simplification in the construction of high power microscope object-glasses, though it is perhaps doubtful whether any great improvement in their corrections can be made. The modern microscope object-glass has reached a technical perfection that would be difficult to surpass—thanks in great measure to the magnificent work of Professor Abbe and his colleagues—and the image produced by the object-glass of the microscope, which is collected and examined by an eyepiece, leaves little to be desired.

It is now well to examine the eyepiece, as when we have corrected our object-glass so that the main image is perfect in the supplementary magnification that is employed to enlarge this picture, no deterioration must take place. The eyepiece most frequently employed in the modern microscope is the Huygenian eyepiece, consisting of two plano convex lenses separated by a considerable interval. Its advantage in giving a large field of view in connection with moderate-sized lenses was discussed in the last lecture, but it has a further very interesting feature, as it shows a different method of making corrections for aberrations. This eyepiece is practically free from central colour aberrations when used in connection with an object-glass. The usual method of correcting a lens for colour has been explained as requiring a negative lens that has great influence on colour combined with a positive lens which has small influence on colour, so that the negative lens, while entirely neutralising the colour error, only partially neutralises the refracting power of the positive lens. The Huygenian eyepiece, however, consists of two uncorrected positive lenses, both of which are made of glass which has the same influence on colour. The correction is curious, and to understand it thoroughly we must remember that there are two chromatic corrections.

FIG. 35.

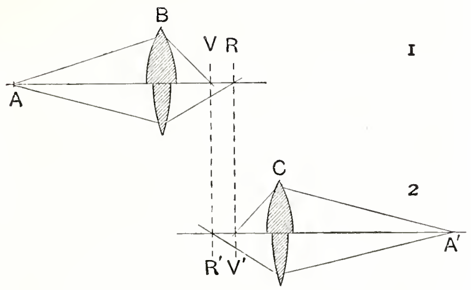


1. Equal focal lengths for different colours, so that the sizes of the coloured pictures may be the same.

2. Equality of position of the Gauss equivalent planes referring to different coloured light, so that the position of the images may be at the same point.

If, as with an object-glass, an actual image is formed in space, both these errors must be corrected, but with an eyepiece which gives a virtual image the latter condition need not be considered, as will be seen from Fig. 35. The violet image may exist at V V′, and the red image may exist at R R′, two totally different positions, and yet if both these images lie anywhere along the lines H V and H V′, their pictures will be super-imposed, and no indistinctness will be caused by their being situated at different positions. They will be the same angular size, and will lie on the lines H V and H V′, provided the total eyepiece has equal focal lengths for different colours. Therefore, the first condition of equal focal lengths only need be satisfied.

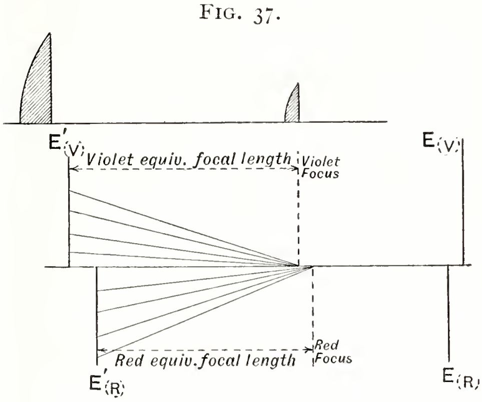
FIG. 36.



It is evident from a diagram, that a pair of uncorrected positive lenses could not produce the different coloured images at the same point. The lens, B (Fig. 36) will produce a picture of the point A, by means of the red rays at R, and by means of the violet ray at V, closer to it.*

Now, consider a second lens, C, forming a perfect image at A′; in order to do this, the upper half, representing the violet light is, as before, a more powerful lens than the lower half, and the violet image if it is to focus to A′, must start from V′, and the red from R′, the very reverse positions to those in which they actually exist after having passed through the first lens. Thus a pair of positive lenses will not produce the images in the same position, and it has been shown that with a virtual image as seen in the microscope, this is not necessary. How then can the chromatic focal lengths be the same, if the positions of the foci themselves are different? Focal length is a measurement of a distance, the distance from the focus to the equivalent plane. If the different coloured foci, which are the points at one end of this distance, are different, the different coloured equivalent planes, which are at the other end, must be different to a similar extent, and the focal lengths can then be the same.

FIG. 37.



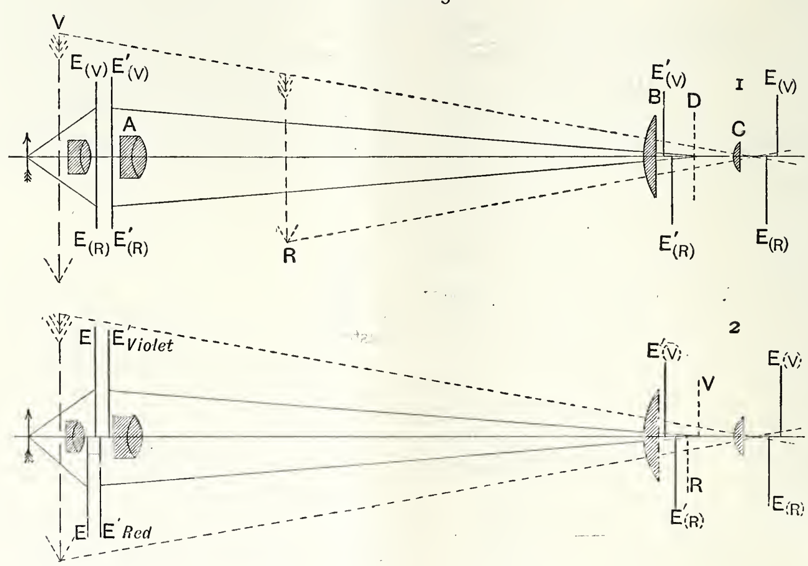
That is exactly what happens in a Huygenian eyepiece. E v (Fig. 37) is the position of the second equivalent plane for violet light, F v is the focus, E r is the red equivalent plane, F r the focus, and the violet focal length, F′ v, E′ v, is equal to the red focal length, F′ r, E′ r.

There is an advantage in this kind of correction when used in combination with a microscope object-glass, in that it allows of two different methods of making a perfect microscope. The object-glass may be absolutely corrected in itself and throw a perfect image into the eyepiece. The eyepiece then produces the different coloured images of exactly the same size, but at slightly different positions, which are, however, as described, superimposed in the eye, or the object-glass may be made so that it gives its different coloured images of the same size, but at slightly different positions, which error is corrected by the eyepiece. Fig. 38 (1) shows the first method when the object-glass has its focal lengths equal for different colours, and also its equivalent planes, and a perfect and superimposed image is thrown into the eyepiece at D, the eyepiece B D then produces virtual images, R R′ and V V′, which are in different positions, but these, however, are

* To illustrate the fact that a lens produces a greater effect on the violet than the red light, it is drawn as a more powerfully curved lens in the upper half of the diagram, than in the lower.

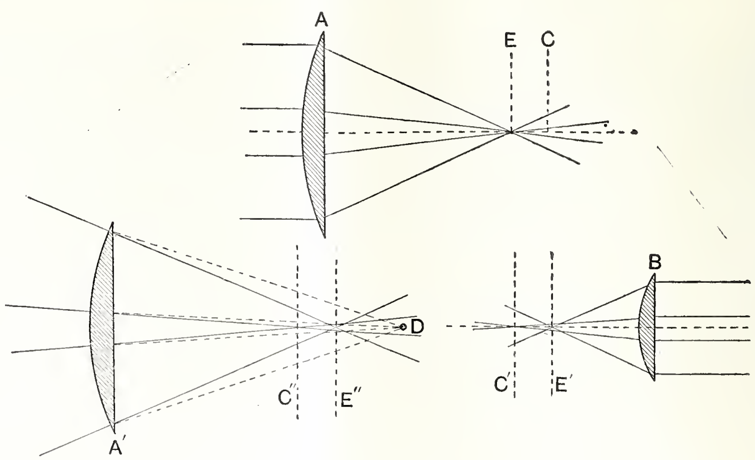
superimposed in the eye. Fig. 38 (2) shows an object-glass which has equal focal lengths for different colours, but in which the equivalent planes are not in the same position, and thus the violet image is thrown into the

FIG. 38.



eyepiece at V and the red at R, just the positions which are required to enable the final images to be produced at the same place. It will be seen that this error of position in the equivalent planes of the object-glass, is of the nature

FIG. 39.



of an uncorrected lens, the violet plane being to the right of the red, and thus the task of correcting an object-glass is rendered somewhat easier. As a matter of practice, a compromise is the usual method employed and an object-glass is generally slightly out of correction. It may here be emphasised that the data given in ordinary text-books should not be used as a basis for accurate investigations of eyepieces. The Huygenian eyepiece is there given as having lenses with focal lengths of 3 to 1, with a separation of 2. The eyepieces by one of the largest English microscope makers are more nearly 2 to 1, with a separation of 1·6. The error of spherical aberration is also corrected in a Huygenian eyepiece, but in explaining the principle the Gauss equivalent planes cannot be used. They do not apply to anything but the central rays, except in the corrected system. The exact explanation is best displayed by mathematical formulæ, but the method can be illustrated (Fig. 39). Suppose parallel

light to be entering the lens A the edge rays will be focussed to E, nearer to the lens than the central rays which focus to C. Now consider a second lens, B; in order to emit a parallel beam the edge rays must enter from E′, and the central rays from C′, which is the reverse of the position in which they are placed by the first lens A, thus for parallel rays this system would not be corrected, but would be worse than a single lens, but if the light is coming into the lens A′ converging to a point D, which is the case in the microscope, a reverse aberration takes place and the central rays go to C″, nearer the lens than the edge rays which meet at E″.

It is evident that under these conditions the lenses, A′ and B, combined together will neutralise the aberration if they are constructed in the right proportions. The intermediate image produced by the lens, A′, is incorrect and fuzzy to exactly the extent that the image would be if formed by the lens, B, with the light going through it in an opposite direction, and thus acting together a perfect image is formed.

The corrections of the rays which pass obliquely through a lens have in the case of the object-glass been disregarded because the field of view of the object-glass is small; it is evident that in the eyepiece this is not the case and they cannot be disregarded. I prefer, however, at this moment only, to mention that the oblique errors are approximately corrected in a Huygenian eyepiece. My brother and I recently described a photographic lens in which the astigmatic oblique corrections have been accomplished with practical perfection although the theoretical convention necessary for this correction has been outraged. Therefore I will not attempt to discuss the recognised theory, which although probably partially correct, does not completely explain the requirements for separated lenses such as an eyepiece.

In the space of one lecture it is impossible to describe the more refined corrections required in an object-glass, such as the spherical aberrations for different colours, the sine correction for different colours, &c., nor is it possible to discuss the relative merits of the orthoscopic, compensating, solid, or Ramsden eyepieces; all that has been attempted has been to show the general principles upon which the microscope built up of simple lenses as described in the first lecture is transformed into an instrument which produces more perfect images.

HOME INDUSTRIES.

Capital, Labour, and Conciliation.—Among the most encouraging of the industrial facts of 1907 was the progress of conciliation, a growing tendency to settle trade disputes not by the crude methods of a strike, but by conferences suggested and carried through with a strong desire to reach agreement. Not for many years past have so many labour troubles threatened; but only once, in the case of Belfast, was there a serious strike, and even then, although the strike in the carrying trades was attended by serious rioting, work was not suspended for any great length of time. The most serious threatened strike of recent years came from the railway servants, who demanded the "recognition" of their union officials, and improved conditions of service. But even here, although the dispute went far, and at one time it looked as if a good many, perhaps the majority, of the men would go on strike, the spirit of conciliation prevailed, and masters and men accepted a scheme of Conciliation Boards to consider all questions of wages and hours, with reference to an independent arbitrator in the event of the parties failing to arrive at an agreement. The settlement effected is for six years, and can only be terminated by one of the parties giving twelve months' notice. Hardly less serious was the threatened strike in the cotton trade, perhaps the most highly organised, both on the side of employers and employed, of our great industries. For a number of years, masters and men in this industry have settled their disputes by mutual conference, but in the autumn it looked as if there was to be war between them. Happily, and largely due to the timely intervention of the President of the Board of Trade, the disputants were induced to come together and accept a basis of settlement. In other directions the same spirit of conciliation has been visible, and it is permissible to hope that 1908 will see a continuance and growth of this spirit, so necessary to the prosperity of employers and employed. It may well be that in 1908 workmen will be asked for greater sacrifices than in the past year, which in the leading industries was one of abounding prosperity. There is a general impression that, although the trade boom in many of the staple industries has not yet quite spent itself, reaction, quickened by the recent financial crisis in the United States, is near at hand. Be that as it may, 1907 has been a red-letter year for workmen and employers in many great industries, and in none more so than in the coal trade, where wages have reached the highest point since the close of the South African war. The miners of the federated districts of England and North Wales began 1907 with a new agreement, signed for three years, with a minimum wage of $37\frac{1}{2}$ per cent., and a maximum wage of 60 per cent. above the standard wage of 1888; and Lord James of Hereford's recent award brings wages up to the maximum standard. In the South Wales coalfield wages have advanced $22\frac{1}{2}$ per cent., and are now at the maximum of 60 per cent., whilst in Scotland wages are now $87\frac{1}{2}$ per cent.

above the standard, the increases obtained during the past year amounting to $47\frac{1}{2}$ per cent., whilst in Durham the wages of miners are $53\frac{3}{4}$ per cent. above the basis, and in Northumberland to $47\frac{1}{2}$ per cent. above it.

Building Societies. — The annual returns issued by the Chief Registrar of Friendly Societies shows that these societies are making steady headway. Taking incorporated and unincorporated societies together the return shows that during the last financial year the income amounted to £43,219,548, as against £38,729,009 in the previous year; while the amount advanced on mortgage was £9,193,221, as against £9,589,864 in the previous year. These figures show that the building societies of the United Kingdom are, as a whole, in a flourishing condition, and although now and again there is malversation of funds by dishonest secretaries, such instances of dishonesty are rare. The societies have done and are doing excellent work in encouraging thrift, and enabling artisans and other persons of moderate means to become the owners of the houses they live in upon favourable terms, at little more, and in some cases even less annual cost than the rents they would have had to pay if the societies had not been there to help them. The building societies represent one only of the three great groups of provident societies with which the Chief Registrar of Friendly Societies is concerned, and the larger friendly societies and co-operative societies offer members facilities for becoming owners of their own houses upon terms which were formerly practically restricted to building societies. Life insurance companies are entering into competition, but the Chief Registrar's figures show that, notwithstanding the keenness of competition, these societies are holding their own.

The Australian Tariff. — The new Australian tariff, so important in its effect upon many Home Industries, remains on many points not very intelligible notwithstanding close study of its provisions. For example, the cables reported that a 15 per cent. tax (10 per cent. preferential) had been laid on cotton yarns. This is a fact but later details show a qualification of the fact. Entered as a "minor" article for the manufacture of cordage cotton yarn may be admitted free. In the shape of sewing or household thread it will escape duty under another heading. The point is what the tariff makers are discriminating against or trying to raise revenue from. If from weaving yarn there is no cotton industry to protect, and the duty will prevent the development of a weaving industry. So with 10 per cent. taxes on jute, hemp, and flax yarns, and 5 per cent. on wool yarns. It is now said that no rebate of duty is to be given on piece goods imported for use in making motor waterproof clothing. No doubt before long uncertainties will be resolved and a clear idea got of the tariff as a whole, but at present there is still a good deal of doubt as to what some of its provisions mean or how they will work.

Farmers and Wheat Supplies.—Farmers who can afford to hold their wheat are likely to be considerable gainers from rise in quotations. As was anticipated the financial crisis in the United States has had the effect of forcing sales not only in that country, but in Canada, with the result that prices have been comparatively low. But already there is recovery, and it is difficult to avoid the conclusion that prices must be much higher before the winter is over. With the possible exception of the Argentine Republic, the wheat crop in all the wheat-exporting countries is below the average. The wheat crop in the United States, according to official figures, amounts this year to 79,000,000 qrs. against 92,000,000 qrs. in 1906. The normal home requirements of the United States are, roughly, 72,000,000 qrs., so that this year the surplus for export is not much over 7,000,000 qrs., but between July and December about 12,000,000 qrs. were exported, so that already reserve stocks have been drawn upon to the extent of about 5,000,000 qrs. In Canada the official estimate of this year's crop is 10,610,000 qrs. against 15,521,000 qrs. last year, Canadian home requirements being about 8,000,000 qrs., whilst the wheat exports since September have been exceptionally large, so that there will be very little left for export after this month, and we must look elsewhere than to America for large supplies. Usually the shortage in one country is made up by surplus in others, but with the possible exception named above this is not the case this year. Of late years we have looked to Russia for large wheat exports, but the last crop is officially estimated at 63,352,000 qrs. as compared with 79,235,000 qrs. in the preceding year, and, taking the last five years, an average crop of 75,500,000 qrs. The average home requirements of Russia are put at about 58,000,000 qrs. per annum, which leaves a surplus for export this year of something under 6,000,000 qrs., but the exports from Russia since August 1st, exceed 5,000,000 qrs., so that little can be expected in the coming months from that country. The position is even worse in India, which, in 1904, sent us 25,500,000 qrs., and in 1905, 22,800,000 qrs. Hardly any rain has fallen in Northern India, which is the granary of India, and cabled reports received last week estimate the area sown in the Punjab at only 5,000,000 acres as against 9,070,000 acres in 1906. Nor is the Commonwealth likely to do anything towards making up the deficit in America, Russia, and India. The total yield is estimated at about 45,000,000 bushels as compared with 66,000,000 bushels in 1906. Consequently a falling off in exports of about 20,000,000 bushels may be expected. In Roumania, which in past years has sent us considerable quantities of wheat, last year's crop was only 5,300,000 qrs. as against 13,600,000 qrs. in 1906. The surplus for export is put at a little over 3,000,000 qrs., of which two-thirds has already been exported.

There remains only the Argentine Republic. Happily crop reports have been favourable, and we may look for large exports from that country, but it is the only one, and under the circumstances described it seems safe to say that the price of wheat will rise before the winter is over, always assuming that American and other reserves carried forward from last year's crops are not much larger than is generally estimated.

Calcium Carbide.—Cheap water-power is an indespensable condition in the manufacture of calcium carbide, and Norway, where cheap water-power is obtainable, has hitherto supplied most of the calcium carbide used in this country with acetylene lamps. But soon the article will be manufactured in Yorkshire, at works adjoining the Yorkshire Electric Power Company's generating station near Dewsbury. The company's mains will provide the necessary light and the several thousands of horse-power required for the manufacture of the carbide, at a price which, it is claimed, will compete successfully with the cheap water-power obtainable abroad. The works are expected to be in full operation in the early part of the present year.

Fire Insurance and Earthquakes.—The sharp experience taught by the San Francisco and Kingston fires has resulted in British fire insurance offices under the tariff agreeing upon special "earthquake clauses," the chief of which is as follows:—"In consideration of the payment by the insured to the company of £ - s. - d. additional premium the company agrees, notwithstanding what is stated in the printed conditions of the policy to the contrary, that this insurance covers loss or damage occasioned by fire during or in consequence of an earthquake. It is agreed that in every case of loss or damage the insured must prove to the satisfaction of the company that no part of the loss or damage claimed for was caused otherwise than by fire." In all cases where the insurance is not subject to average there will be an additional clause declaring that the principle of average shall apply to loss or damage caused by fire during or in consequence of an earthquake. A schedule has been prepared fixing rates for "earthquake risk" in all parts of the world except the United States and Canada. In this connection some remarkable figures compiled by the *New York Journal of Commerce* may be noted. They show that deducting conflagration losses in 1904 and 1906, and taking eleven months of five past years, 1907 exceeded the average by more than $30,000,000, the average of 1903 to 1907 being only $166,367,000, while in 1907 the fire loss was $199,887,000, a 16 per cent. increase.

Colour Manufacturers.—The new patent law requiring the production of patented articles in English works is having the anticipated effect in bringing German colour manufacturers to this country. The directors of Meister Lucius and Brüning, of Höchst, have intimated their decision to commence manufacturing in England, and have made arrangements for the erection of a plant here, and it is expected that other German colour manufacturing companies will follow suit. It is thought not unlikely, in view of the policy of combination which has been such a marked feature in the German colour industry, that there will be similar joint action on the part of German colour companies in England, and that one or two works here will be used for all the leading German colour manufacturers.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

January 15.—"Screen-Plate Processes of Colour Photography." By C. E. Kenneth Mees, D.Sc., F.C.S.

January 22.—"Siam and its People." By Harry Hillman.

Dates to be hereafter announced:—

"The Problem of Road Construction, with a View to Present and Future Requirements." By H. S. Hele-Shaw, LL.D., F.R.S., and Douglas Mackenzie.

"Recent Improvements in Decorators' Materials." By A. S. Jennings.

"The Underground Water Supplies of the Thames Basin." By Clayton Beadle.

"Industrial Entomology: the Economic Importance of a Study of Insect Life." By F. Martin Duncan.

"Modern Dairy Practice." By Loudon M. Douglas.

"War Balloons." By Auguste E. Gaudron.

"The Application of Science to Foundry Work." By Robert Buchanan (President, Staffordshire Iron and Steel Institute).

"The Law of Treasure Trove." By William Martin, M.A., LL.D.

"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By Ernest R. Matthews, F.R.S.E., Assoc.M.Inst. C.E.

"The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds." By Lovell N. Reddie.

"The New Patent Act." By John William Gordon.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

January 16.—"Indian Agriculture." By Henry Staveley Lawrence, I.C.S., Director of Agriculture, Bombay.

February 13.—"The New 'Imperial Gazetteer of India.'" By Richard Burn, I.C.S. (To be read by William Foster.)

MARCH 12.—"Progress of Native States during the past Forty Years." By SIR DAVID W. K. BARR, K.C.S.I., Vice-President of the Council of India.

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

JANUARY 28.—"The Development of Colonial Self-Government in the Nineteenth Century." By A. BERRIEDALE KEITH, M.A., B.C.L., M.R.A.S.

FEBRUARY 25.—"Irrigation in Egypt under British Direction." By SIR HANBURY BROWN, K.C.M.G.

MARCH 24.—"The Mineral Resources of Western Australia." By the HON. C. H. RASON, Agent-General for Western Australia.

APRIL 7.—"The Imperial Problem of Asiatic Immigration." By RICHARD JEBB.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

JANUARY 21.—"Developments in the Art of Jewellery." By Mrs. HADAWAY.

FEBRUARY 18.—"Banners." By GEORGE W. EVE. WALTER CRANE, R.W.S., will preside.

MARCH 31.—"Enamel Portraits." By CYRIL DAVENPORT, F.S.A. SIR HUBERT VON HERKOMER, C.V.O., R.A., will preside.

APRIL 28.—"Lace as a Modern Industry." By Miss ISEMONGER.

MAY 26.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

HENRY HARDINGE CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." Six Lectures.

January 20, 27, February 3, 10, 17, 24.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

FEBRUARY 7.—"The Hygiene of the Pottery Trade." By WILLIAM BURTON, F.C.S., Chairman of the Joint Committee of Pottery Manufacturers of Great Britain.

FEBRUARY 28.—"The Removal of Dust and Fumes in Factories." By JOHN SCOTT HALDANE, M.A., M.D., M.R.C.P. (Edin.), F.R.S.

HOWARD LECTURES.

Thursday evenings, at 8 o'clock :—

H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

March 19, 26, April 2.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 6...Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. R. J. Friswell, "Preparation of Paratoluidine from Mixed Toluidines by Means of Para Toluidine Hydrate." 2. Mr. H. W. Rowell, "The Determination of Small Quantities of Bismuth."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Rev. Professor G. Frederick Wright, "The Influence of the Glacial Period upon the Early History of Man."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Arnold White, "The Problems of a Great City."

TUESDAY, JAN. 7...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Sir David Gill, "Astronomy, Old and New." (Lecture V.)

Photographic, 66, Russell-square, W.C., 8 p.m.

WEDNESDAY, JAN. 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "The Scientific Applications of the Cinematograph." (Lecture II.)

Geological, Burlington-house, W., 8 p.m. 1. Dr. Henry Clifton Sorby, "The Application of Quantitative Methods to the Study of the Structure and History of Rocks." 2. Prof. George Frederick Wright, "Chronology of the Glacial Period in North America." (Communicated by Professor E. J. Garwood.)

Japan Society, 20, Hanover-square, W., 8½ p.m. Mr. M. Garbutt, "Military Works in Old Japan."

Junior Institution of Engineers (at the HOUSE OF THE SOCIETY OF ARTS, John-street, Adelphi, W.C.), 8 p.m. Mr. Fitz Roy Roose, "Recent Improvements in Electric Conduit Traction Construction."

British Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, JAN. 9...Antiquaries, Burlington-house, W., 8½ p.m.

London Institute, Finsbury-circus, E.C., 6 p.m. Rev. A. S. Palmer, "Some Survivals in Folk Lore."

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Sir David Gill, "Astronomy, Old and New." (Lecture VI.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. F. C. Snell, "Cost of Electrical Power for Industrial Purposes."

Mathematical, 22, Albemarle-street, W., 5½ p.m.

FRIDAY, JAN. 10...North-East Coast Institute of Engineers and Shipbuilders, Westgate-road, Newcastle-on-Tyne, 7½ p.m. 1. Discussion on Mr. J. H. Heck's paper, "The Effect of Work and Time on the Properties of Mild Steel and Iron." 2. Discussion on Mr. W. G. Spence's paper, "Notes from Four Years' Working of the Educational Committee's Recommendations. 3. Mr. H. R. Jarvis, "Floating Docks."

Astronomical, Burlington-house, 5 p.m.

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Sir Charles Nicholson, "The Kingston Earthquake and Building in Jamaica."

Philological, University College, W.C., 8 p.m.

Journal of the Society of Arts.

No. 2,877. VOL. LVI.

FRIDAY, JANUARY 10, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 15, 8 p.m. (Ordinary Meeting.) C. E. KENNETH MEES, D.Sc., F.C.S., "Screen Plate Processes of Colour Photography."

THURSDAY, JANUARY 16, 4.30 p.m. (Indian Section.) HENRY STAVELEY LAWRENCE, I.C.S., "Indian Agriculture."

Further details of the Society's meetings will be found at the end of this number.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready and can be obtained by members on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

JUVENILE LECTURES.

On Wednesday afternoon, January 8th, Mr. F. Martin Duncan delivered the second and last lecture of his course of juvenile lectures, on "The Scientific Applications of the Cinematograph."

Before describing the general application of the cinematograph to the study of zoology, the lecturer said he would give another illustration of the value of the instrument in recording the life histories of insects, by exhibiting the daily life of the wood-ant. A great fight of ants and a successful attack upon caterpillars was presented on the screen. He said he had very great difficulty in obtaining these pictures, on account of the small size of the insects, and the extraordinary rapidity of their movements. These fearless little creatures resented his intrusion, and frequently sent out small armies which swarmed over him and his apparatus, evidently with instructions to drive him away or cut him up with the aid of their powerful jaws, and cart him away in pieces to the nest.

The lecturer showed what the cinematograph has done for the advancement of the study of animal life, by the exhibition of some of the collection of animals that Carl Hagenbeck has placed in the great compounds in his wonderful Zoological Park, at Hamburg. On the screen were shown large numbers of wild animals in their natural haunts, and all kinds of beasts and birds were seen. The most striking of the pictures was an exhibition of the antelopes leaping.

The lecturer enlarged on the value of the cinematograph in many of its scientific applications, and in conclusion he showed a series of vivid representations of scenes in the daily life of the inhabitants of Morocco—street scenes and processions of the Sultan and of his army.

In illustration of some of the mechanical industries of the country were shown the operations in a granite quarry, and a picture of the blasting of the rock. Then were seen the successive processes of the construction of a railway carriage, beginning with the transport of the timber and the work of the sawmills. The making of the carriage followed, showing the successive growth of the flooring, the uprights, and the finishing off of the roof.

Finally, the lecturer enlarged on the great value of the geographical application of the cinematograph.

The CHAIRMAN (Sir Steuart Colvin Bayley, K.C.S.I.) proposed a cordial vote of thanks to the lecturer for his interesting course, which was carried unanimously.

APPLIED ART SECTION.

Tuesday evening, December 17; Sir ASTON WEBB, R.A., F.R.I.B.A., in the chair.

The paper read was—

HOW TO MAKE THE MOST OF A MUSEUM.

By LEWIS FOREMAN DAY, F.S.A.

INTRODUCTORY.

My paper is really addressed to those concerned in the arrangement, ordering, and conduct of museums, and especially of a museum of Decorative and Industrial Art—what in Germany they call a "Gewerbe Museum." But it was difficult to put that into the three or four words of a heading; and I have adopted a title which, if it is not so explicit as it might be, allows me, by way of preface, to say a word or two to some of my brother artists with whom I cordially disagree.

How to make the most of a museum?

Well, in the first place, the way is *not* to belittle it. And that is what is constantly done by artists who ought to know better. Never a man of them will confess to the least unfriendliness towards museums. They will even admit, when driven to it, that museums are quite admirable institutions; but the admission is followed up by qualifications which more than nullify anything admitted in their favour. Of course, there are no opponents of museums—or no outspoken ones—when it comes to a definite pronouncement for or against them; but there is quite a school of artists who lose no opportunity of letting it be known in what small esteem they really hold such institutions. I feel bound, therefore, by way of preliminary to what I have to say about making the most of them, to enter a word in answer to those who make so little of museums, who, in fact, admire them as they may, persistently damn them with praise as faint as they dare make it.

The depreciation of museums, or let me rather say the condemnatory admiration of them, comes mainly from the side of sentiment. Museums, they complain, are the cemeteries of art—"dreary charnel houses of dry bones" is one of the pet names I have heard applied to them—nothing is alive in them, everything is fragmentary and out of place, and the effect of it all is only bewildering.

I grant you the bewilderment; but that is not the fault of the museum (assuming it to be what it should be), but of those who come to it all unprepared. Aud I can't help feeling that one of the objections of the would-be-free artist to museums is, that they ask of him an amount of preparatory study which he is not inclined to give to his art. If students are overpowered by museums, it is because they have not been prepared for them as they should have been. It is the fault, not of the museums, but of the teachers who don't teach the use of them, the fault, in fact, of the very men who accuse them of bewildering. It would be a very poor museum which did not contain more food for the mind than your weakling can digest! But if he over-eats himself there, it is no fault of the feast. Of course the student wants direction in a museum, as he does wherever he studies—though there is an idea abroad that the way to teach is to leave the student to his own devices. Anyway, the sooner he learns to walk alone and to choose for himself the better (the faculty of selection is, after all, part of an artist's equipment for his calling). As for those who cannot concentrate their minds on what concerns them, that again is not the fault of the museum, but of the wavering modern mind. It calls itself "open," I believe.

What if things are fragmentary in a museum? We notice in a fragment things which would have escaped attention in the whole. What if they are seen out of their natural surroundings? We see them perhaps nearer, and in a better light, than if they had been *in situ*. Besides, who has not seen things rotting away in their "natural" surroundings, so uncared for and degraded that he would have preferred for them the decent burial, if you like to call it so, of a museum?

There may be something rather pathetic in the bringing together of so many remains of the past; but if anyone finds it altogether depressing, is not that the fault of his temperament? To a healthy activity, there is something stimulating in a museum, to a creative instinct something inspiring. They say it tempts one to go and do over again the same old things. If it does we may safely put it down, not to the force of ancient example, but to the weakness of modern initiative.

Time was when they had no occasion for museums. We cannot do without them. They are a necessity of our times: (1) to preserve what else would be lost (we cannot keep standing every crumbling old building in which there is a scrap of iron worth saving);

and (2) to counteract the growing tendency of manufacture to take no account of styles of work and methods of workmanship which, as they say, "don't pay."

In speaking up for museums, I have taken it for granted that they are of the right sort.

What do I mean by the right sort?

All sorts are right, or may be. And there is room for all sorts. I am concerned with the sort of museum which students of design and workmanship want—or ought to want—the sort which would be useful to them; and I am going to try and tell you what that is. There are other kinds perhaps quite as necessary, or more so; but that is not my affair—or not to-night. I speak for the kind I want, leaving it for others to say if they think I make any preposterous demand, or to suggest how the end which I suppose we all have in view might more easily be attained.

I am far from thinking to solve right off the difficult question of museum arrangement. I do not even pretend to discuss it from more than one side. All I hope to do is to throw some light upon that side—to show, in fact, what working artists think a museum of decorative art should be.

Everyone has heard of La Thène where, in a forgotten graveyard, were discovered remains of Celtic art, which mark an epoch in the study of ancient civilisation. But not everyone has been to Hallstadt, near by, where great part of this famous treasure is preserved. It is housed in the picturesque old prison-house that was. And it is shown in such a way as to bring the discovery of the prehistoric cemetery vividly before us. It is really illuminative to come upon a skeleton figure lying in the position in which it was found, arm and leg bones encircled with bracelets which have left a ring of colour where the copper oxide dissolved from the bronze has stained them green. So, when we climb to the upper rooms of this quaint little building, and find them furnished much as they must have been when the gaoler and his family first went to live there, it brings us nearer to the life of the past, and we feel that a building which had outlived its time could not possibly have been put to better use.

In this little local museum we have the simplest expression of an idea which has taken deep root in Germany and other countries—the idea, that is to say, not merely of what the Germans call "Cultur-Geschichte," but of teaching, as it were, by *object lesson*.

This idea is developed in a very attractive way in the museum at Salzburg, a moderm building so contrived as to represent a number of old dwelling rooms, each with furniture and everything so carefully collated as to present in effect a series of interiors more or less representative of the sixteenth and seventeenth centuries or thereabouts.

There is no denying this to be a form of exposition calculated to catch the attention of the least curious of sightseers. It must excite at all events a momentary interest in the past, and should arouse a healthy curiosity to know more about it. And our enjoyment of the Salzburg museum is unalloyed. We ask of it no better than the pretty peep it gives us into the long ago. This practice of fitting up museum galleries as though they were living rooms of various periods is most acceptable in museums of what is practically the peasant art of a locality, artistically interesting always, but of no great technical value.

Teaching by object-lesson has been tried on a magnificent scale in the new museum at Munich. There the idea was to arrange the principal collection of Bavarian art in such a way that, beginning with prehistoric times, one had only to proceed from room to room through the successive periods of history, beginning with the earliest, and arriving by degrees at the latest stages of the national arts and crafts.

There is something very attractive in the notion of this pilgrimage of improvement. And it has been admirably carried out. It is delightful to see how evidently the building has been designed to hold its contents—how cunningly the salvage from the old buildings has been used. Carved and painted rafters, ceilings, doorways, and other structural woodwork, have been incorporated in the new building without losing their value as objects in it. And it was a very happy thought to arrange a great hall of ecclesiastical art with side bays where, as in a series of little chapels, all manner of things belonging to the Church could be shown, not only in surroundings proper to them, but in something very much like their natural position and relative importance. In fact, the consecutive exhibition which occupies the ground floor of the great building is something not to be forgotten. It gives one a glimpse into the development of native art at the same time that it emphasises its National character. That is, in fact, its justification.

Members of Parliament, who have been abroad for their holiday, come home and tell

us how much better they do this sort of thing in Germany. Do they? That is the question. If the one purpose of a "Gewerbe Museum" were to illustrate history, and the one way of illustrating history were by means of object-lessons, then, indeed, it might be said with truth that Germany has shown us how to set about it; but, if, as I maintain, it is sheer misuse of art to reduce it to the service of history, then Germany may more truly be said to have demonstrated for us how not to do it.

Education by way of object-lesson is a form of teaching so elementary as to be out of place in a great museum; it belongs by rights to the Kindergarten. And it is astonishing, when you think of it, that the pedagogic idea which is at the root of it all should have resulted in a course of instruction more in the manner of the popular lecturer or the purveyor of amusement than of the serious professor of art. When it runs, as it does abroad, to dummy figures dressed up in the costume of the period distributed about the room or in cases, it verges very closely upon the puppet show. The effigies may attract you at first; but the more you see of them the less you can endure them, and the more sure you become that, outside of an ethnographical or historical collection, such things are a mistake.

The theory is that things should be shown as nearly as possible in their original surroundings, those being of course the conditions under which it is easiest to enter into the sentiment of them. I have not a word to say against the theory. Only in practice it does not work. The idea of showing things in their natural surroundings is to some extent realisable. To environ them with their proper associations is not possible. The sentiment belonging to domestic, ecclesiastical, or historic relics, is not proper to the museum. Indeed, it is contrary to it; for a museum is, after all, only a sort of enquiry office. It is not the place to inspire the sentiment we feel in a room that people live in, in a church where they worship, in a building still the centre of their public life—and it is of no use arranging it on the supposition that it is.

Sentiment may send folk there to learn more about what has already impressed them. They may find there the material on which to feed sentiment; they may discover there the means of expressing the sentiments they feel; but it is manifestly not the place for sentiment. And sentimentalists themselves allow this when they contemptuously describe a museum as a sort of herbarium of specimens, a collection of only the dry and lifeless husks of things. Dry they may be; but there is in them the seed of living production—and it is ready garnered for us there as we find it nowhere but in a museum.

There may be very good reason against placing things in the position they would naturally occupy. Their "proper" place may not be the one where they can be properly seen and studied. The place for a beautiful necklace is on the neck of a beautiful woman; but that is not the position where the work of the goldsmith and enameller is most conveniently to be studied. And so with the furniture and contents of a dwelling-room. What we want to see are the things themselves, down to the last detail of their execution, not merely what they look like in a room. No doubt it is helpful to have also here and there the more comprehensive exhibit of an interior, to illustrate domestic decoration as distinct from the art and workmanship of the things which go to make it; but to show cabinetwork, embroidery, ironwork, &c., as parts of an interior, it hardly to *exhibit* them at all.

A great deal too much has been made of the fact that in a museum we see things without the atmosphere proper to them, in a light perhaps different from that for which they were designed. I don't think that in a well-planned, well-arranged, properly administered museum, this last fault need prevail to any great extent. But, in so far as it does, it may not be so fatal as it sounds. Even the light that is not altogether favourable to a work of art may, and often does, illuminate some point of workmanship which is of great interest to the student. And it may sometimes be the business of a curator to call attention to points of workmanship upon which the artist who did it would not have desired to lay particular stress.

The misfortune of seeing things without any environment of sentiment and association is, then, by no means unmitigated. Sentiment and association are, it is true, necessary to appreciation of the poetry of art, but not to the understanding of its technique. I will go so far as to say that to see things with a halo of sentiment round them is to see them without the clearness and precision necessary to thorough recognition of their purely workmanlike qualities.

I take, you see, a quite prosaic view of the situation. I would have the things in a museum set forth with a view first to the understanding of them, not to delight in them—though there

is no end to the joy we get of them once we know how to use them. After all a museum is not a story book, but a work of reference. Would anyone pretend that it should or could breathe the spirit of romance? Then why not frankly acknowledge its strictly utilitarian purpose? There is underlying the poetry of decorative art a solid foundation of prosaic common sense. Inspiration itself is not independent of knowledge—the knowledge of materials, of construction, of ways of working, of composition, and other things nowhere so conveniently to be studied as in a museum. Museums, then, even the most strictly practical, do add, if not to our immediate delight in art, to right appreciation, and thus lead up to the fuller and more perfect joy in art experienced when we meet it under conditions which allow full play to the poetic emotions.

The demand is all for popular museums. But what do you mean by popular? The purpose of a museum is, not to do away with the necessity of study, but to light the way for the student—student of course including every handicraftsman who takes an intelligent interest in his work, and every amateur who wants to know good from bad, and why it is good or bad. To this end a museum should be arranged for study. A museum is the one place where it is possible to put things side by side, and in strict series, so as to show, not only the sequence of design and craftsmanship, but design and craftsmanship themselves, and the relative merits of the work. The order of arrangement should be that rather of artistic and technical development than of historic periods — very much the same thing, you may say; examples arranged historically will inevitably illustrate the course of craftsmanship. So they will; but not so thoroughly. And it makes a very real difference which plan is followed.

The plan I am advocating is to take the arts and crafts separately, to illustrate each one of them as thoroughly and to show its development as logically as it is possible to do. If the separate collections can be grouped so as further to afford a survey of the whole realm of art—by all means. But one art at a time is all that most of us can swallow. "Art," with its big A, is rather too much of a mouthful.

You must not suppose that I imagine it a simple or easy thing to plan the arrangement of a museum. Over and above the rival claims of art and history, there is the question of Country to consider; for the development of craftsmanship in one part of the world does not obligingly coincide in point of time with its course in another; nor do the national treasures divide themselves up just in the proportion which would suit the beautifully symmetric plan which we may have in our head. There are difficulties in the way of any plan. We are driven in the end to adopt, not the ideal one, but the one that is possible.

I am assuming that practically it is not possible to satisfy equally the student of art and the student of history, and contending that, in the sort of museum we are talking about, art—and practical art too—should be the dominant consideration. The point of view of the student is this (and I speak not only as a lifelong student myself, but as one who has had charge of students in a museum), we want to see the best in art and handicraft, and to see it so placed that we can study it for what (apart from the domestic, historic, or ethnographic significance of it) it may be worth as art and workmanship.

To the student of design and workmanship, and yet more to the student of some one branch of either, it is not enough that he may find here and there in a great collection, historically arranged, beautiful examples of the art he is studying; he wants them brought together for minute comparison; and he comes away from even a wonderful museum like that at Munich with the feeling that its artistic, and still more its technical, use has been in a measure sacrificed to the pedagogic idea of "Cultur-Geschichte." It is not only the course of art, but, even more, the development of a *particular* art, which a workman is concerned to know about.

The South Kensington Museum, which was the parent of "Gewerbe Museums" all the world over, set out on the right road, and in the main has kept to it—though the severance of Western art from the Oriental, to which it owes so much, is not in the interest of craftsmanship. The Clûny followed suit, though it is difficult in a mediæval "hôtel," planned for a very different purpose, to arrange things in the strict order of craftsmanship. The delightful old buildings at Nuremberg with their modern additions—a veritable nest of technical collections, themselves divided into sub-divisions (furniture, for example, having a section to itself among woodwork, and church work being divided from domestic) keeps in the main to the track of craftsmanship. And in justice to the "Gewerbe Museum" at Cologne, I must say that I can think of no museum which holds

closer than it to the strict plan of arrangement according to technique, nor any in which it is quite so easy to pursue the thing you want.

But I think we abase ourselves rather too abjectly before the German genius for scientific arrangement. No doubt the Germans have a talent in that way. But they have not had to face the difficulty of setting in order collections such as we possess in the British and the Victoria and Albert Museums. We suffer from riches with which they are not embarrassed. Dr. von Falke, for example, at Cologne, began with a clean slate, and had to do with collections which were not big enough to be unwieldy.

What, with our abundance of material, we might perhaps do (this is an age of specialising), is to house under one roof a series of museums in each of which the course of some one particular art was shown ; or, if it is objected that " all art is one," then I will say a series of museums confined to the various crafts in which art has manifested itself ; for all practical purposes the connection between, for example, weaving and wood-carving, ends with the W, with which they both begin.

The difficulty of determining which way to proceed is only postponed by trying to go both ways at once. Put the idea into definite words, and the futility of it is obvious. For awhile the two courses may run parallel ; but there comes always a point—sooner rather than later—where any two purposes diverge, and it is of no use putting off the day when choice is to be made between them. It sounds feasible and fair enough to devote one floor to Historic sequence, and one to the development of Craftsmanship. That was tried at Munich. To judge by the two floors, it might seem as if the order of historic sequence, and not that of craftsmanship, were the one to follow. But that is not a fair conclusion to draw. The fact is that one collection is (as it was practically sure to be) strengthened at the expense of the other. The organising director of the two has naturally some bias of his own ; and it may very likely end in his throwing to one collection the scraps not wanted for the other. At Munich the inevitable happened, and the Technical collection was robbed to furnish forth the Historical. This is very plainly seen in the section devoted to ironwork. It is a beautifully arranged and quite striking display ; but, to judge by what I saw there, the art of the smith might have sprung suddenly into life towards the end of the fifteenth century ; the forged iron of earlier date is all shown on the other floor.

It is conceivable that in a London museum, we might, with our wealth of things, quite adequately illustrate both History and Craftsmanship ; but, even then, the perfect representation of one or the other would depend upon the bias of the man in authority. For it is not a question as to the relative importance of art or craftsmanship on the one hand and of history or civilisation on the other—each is in turn the more important—but as to the one which is our concern. What primarily concerns the artist or craftsman is art or craftsmanship. History concerns him too ; but it is with him a secondary consideration, pressing only in proportion as it may help him to follow the progress of craftsmanship and the development of design. An artist learns most from actual works of art. Their history has much less to say to him. My plea is for a study place schemed with a view to his wants—not on any theory as to the way artists and workmen ought to learn, but on the knowledge of how they do learn and can learn. Some other way may be ideally perfect ; but if it is beyond the range of the powers (and weaknesses) which go to make an artist or a workman, it is practically of no use.

Only a quite uncultivated person, I suppose, would wish to shut general culture out of education, however specifically artistic. All that the specialist would say is, that it wants keeping in its place. It is no more than logical to ask that in a museum of art everything should be secondary to art, and to the particular form of art the museum was designed to promote. I am asking for a museum arranged on the assumption that it is for study, and for the study of art and craftsmanship, and especially for the use of workers—of persons intent, not so much upon general culture or learned erudition, as on acquiring a thorough knowledge of the business in which they are engaged, of persons, that is to say, interested in the *practical* side of the question. The purpose of those who want to learn is only half served by the too popular show place.

It is not only artists and handicraftsmen who want to study old work closely—to see what has been done, how it was done, and how it is possible to do it. That also (whether they know it or not) is the pressing need of connoisseurs and collectors, at present handicapped by not knowing enough about the intrinsic and workmanlike qualities of the

things they care for and collect. A museum planned on truly educational, as distinct from popular, lines is the one place where persons who have not access to a workshop have some opportunity of acquiring the technical knowledge, without which they can not be either appreciative in their connoisseurship or judicious in their collecting.

There is not much in common between the idea of exhibiting which I have tried to put before you and the fashionable one of building up and furnishing interiors to illustrate historic periods of design. That is the new idea of which we are so proud! But it does not happen to be new. It is more than half a century old, to say the least. It is the old idea of the middle of the nineteenth century. Only at the Crystal Palace we called the rooms "Courts." The modernity of the idea consists in adhering closely to models, instead of trying to create types of ancient decoration—which is good—and in exhibiting real old work instead of reproductions. That is so unnecessary as really to amount to reckless waste of precious material. Were the object-lesson in historic decoration ten times more necessary to popular education than it is, there would be no occasion to rob the technical museum to provide it. The truth is that, apart from sentimental interest, copies answer all the didactic purpose of original work. There are some reproductions of interiors (at Vienna, I think it is) which leave, as object-lessons, nothing to be desired. When once the newness has worn off, it will take an expert to tell that the carving and inlay and painting are not old. And it is not the expert who wants information conveyed to him in pictures.

There is the further advantage about reproductions that it is possible to acquire a complete unbroken series to illustrate your subject, whereas in any collection of real rooms there must be gaps it is impossible to fill. What could be better in the way of object-lesson than the museum of architectural casts at the Trocadero? At Altona, where they have set up in the same musem both authentic interiors and small scale models of old North German dwelling-houses, the lesson is in either case equally convincing.

If it is argued that, without such help as the complete interior affords, it is impossible to understand the things shown in a museum. Well, it has not been suggested that here and there a room complete should not be exhibited to show that. But the fact is that, for the most part, dummy rooms would answer all the purpose, or models, or even photographs, and water-colour drawings—which last any clever young architect could make under the direction of a responsible antiquary. And there is one final objection: suppose these illustrations of historic periods to be what is popularly wanted; is it not very much what every big decorator is doing in his shop? Badly, you will say. But it is not the object of a museum to teach the tradesmen how to do it well enough for trade purposes. And that is all he wants to do—as tradesman. As artist or craftsman he wants the education which a musem of the kind I am advocating would give him.

The foundation of a museum has been in many cases a private collection, which some princely collector housed in his palace, and set forth in the way that seemed best to adorn it. When he made it over to the public, he made the palace over with it—or, if not, the grateful recipients of the gift (or it may have been the purchasers) looked out for an empty palace to house it in. Failing that, they built one for its reception. And, so strong is the force of association, that they cling still to the notion of a palace. You may see in Semper's twin museums at Vienna (finished only twenty years ago), the obsession of the palatial idea. They adorn the Ring, but as museum buildings they are quite out of date.

It is one thing to house a private collection for personal enjoyment, or a royal collection for display, and another to exhibit a public collection to the public advantage. We are beginning to realise that. Museums like the Musée des Arts Decoratifs at Paris, like the Nordiska Museum at Stockholm and the museum at Cologne—I must not mention the last new building nearer home—are planned to meet the new conditions of a public museum.

The rational idea of a museum building is not so much that of a palace of art—though we use the term by way of "high falutin"—as of a glorified warehouse. That is what a museum actually is—a storehouse. Grant the necessity of arranging for the display of the stores, for their disposal upon some practical and easily intelligible system, and for circuit through the galleries, and you have the absolute conditions of planning. Grant the further desirability of housing great possessions worthily (I said, you will remember, a "glorified" warehouse) and what more is there to do? I am not venturing (in the presence of the Chairman) to discuss the ground plan and ele-

vation of a museum. The elevation would grow, I take it, out of the plan, and the plan out of the conditions of public exhibition and so forth. That is not my province. But the palatial idea extends beyond the plan and elevation of the building and into the disposal of things in it. At times that may be inevitable. In a building like the Louvre, for instance, the things, you may say, have to live up to their housing. (Perhaps, too, the housing of art treasures in ancient buildings may have been at the beginning of the idea of furnishing rooms *en suite*.) What I want to insist upon is that the arrangement of things in a museum should not be governed by the idea of furnishing or of decorative effect.

Once admit the controlling idea of decorative effect, and you open the way to placing things wherever they may happen to fit into a scheme of decoration. The student has to find them. That is not exhibiting.

To a decorator—and I speak as one of them myself—there is an irresistable temptation to arrange things decoratively. His first thought in hanging a picture, for example, will be, not so much what is due to the painting, or the light which suits it, but where it will best adorn the room. In the case of a given picture that may or may not be a matter of serious regret. In the case of museum - decoration this attitude of the decorator is opposed to the very use and purpose of the institution. Not but what there is room in any great public building for all the decoration (mural or otherwise) that the money will run to. By all means let there be a flourish of artistic trumpets in the vestibule, on the staircase; and there may be other parts of the building, distinct from the exhibition galleries, which call for decoration. But the galleries themselves are sufficiently decorated by the things in them. That is all the decoration they want, or will bear. There was never a greater mistake than to paint them in any but the simplest way, or to treat them, in fact, as anything but background.

It is argued sometimes that the rooms should be decorated in the style of the collections in them. Well, the nearer the decorator goes to that the more surely he detracts from the prominence of the things to be shown. The more intent he is upon the *ensemble*, the less consideration will he pay to the purpose for which the gallery is there. There is no fear of not paying due attention to decorative effect. A man of any taste can't help doing so, and the least possible regard for art (a museum director can hardly be without that) will be enough to ensure that in the arrangement of things according to their intrinsic interest and artistic value, there shall be no shock to our sense of colour and so forth. That is all he has to do in the way of decoration. His task is not to furnish handsome galleries, but to show things fairly.

In a scheme of decoration individual things get merged in the whole. Things exhibited have, on the contrary, to be brought into individual prominence. They want more or less defining against their background. They have to announce themselves. The reticence proper to decoration is in their case not to be desired. It is the decoration which should be reticent—in a museum. It is of no use, however, trying to restrain the natural inclination of the decorator to show what he can do. It would be easier to find a decorator worthy to be associated with the nameless craftsmen whose works are housed in the museum than to keep him in his place when found. Where is the decorator who has no desire to shine as an artist, who is ready to efface himself and make way for the least of the little masters? And, were his design and workmanship to compare with theirs, it distracts, confuses, and in the end worries us. The danger of ambitious decoration in a museum is so enormous that I, for one, would rather not see it attempted.

The cruellest cut of all is where decoration absorbs, as it commonly does, the light—so badly wanted in a museum, and so difficult to get. The subdued light which makes a room habitable is just what we do not want in a museum. There we have need of all the light we can get, or it is impossible to see clearly enough the details of design and execution which alone will tell us what we want to know. We go a museum to see things, not to get impressions—and to sacrifice light to effect seems to me little short of a crime. Yet we find in museums not only heavily painted walls and ceilings which reflect the minimum of light, but modern stained glass windows that literally shut it out. A case in point occurs in the Ryks Museum at Amsterdam. I hardly know where you could find rooms less fitted for the display of art and handicraft than those decorated in Byzantine, Gothic, and other historic styles. There is a room, too, hung with old leather, beautifully rich in tone; but you can't see the things in it—nor yet the leather properly.

Does there exist a museum in which there is light enough? At Salzburg things which seem worth study are quite in the dark. At Munich precious things like enamels are in such obscurity that they might as well not be there. At Buda-Pest some of the rooms are so dark that even in the morning light half their contents cannot be studied at all. And these are all modern museums, built for their purpose. In the Historic Museum at Stockholm, mediæval art is seen in a dim artistic light akin to darkness—because they had the "happy thought" of showing Gothic furniture under Gothic vaulting. Again, the vaulted chamber in the Munich Museum, "appropriately" Gothic, is not appropriate to the showing of armour. Think of the armoury at Madrid? In a town museum there must always be a difficulty in getting light. And, the question is, not so much where it comes from, as how to get enough. In picture and sculpture galleries, of course, this is different.

Certainly we can't afford to have light eaten up by dark colour. There seems to be a lingering prejudice in favour of dark red and dull green gallery walls. The colour needs, of course, to be chosen with a view to the things exhibited. It makes all the difference whether it is to be a background to Bronzes or to Pottery, to Glass or to Goldsmith's work, and so forth; but it need not in any case be dark. As to strength, all that is really wanted is depth of colour sufficient to hold the effect together and prevent the ugly isolation of each separate thing.

I have been taking note of the background colours in museums, and I find some of the most satisfactory colours are: yellow no stronger than Siena marble, red no deeper than new-cut cedar wood, green no heavier or more positive than a duck's egg or a sage leaf, blue not more intense than an average English sky—none of which tints absorb much light. In the new Nordiska Museum at Stockholm, they make constant use of hempen canvas, the colour of string or sacking, both on the walls and as a lining to the cases, and the drab effect is not in the least unpleasing. At Hamburg, fine Japanese matting (texture always counts of course) makes an excellent foil for blue-and-white and some other kinds of pottery. In any case there is no need to carry the colour higher than say nine feet from the floor, the distance from the eye, in fact, at which it is fair to show things. And above that why not have everything white? as it is in the Nordiska Museum at Stockholm. For some things white itself is the best background. Light we must have. And I would do anything almost, to get it, even to the use of mirrors to reflect it where it was not otherwise to be got. In rooms where it was impossible to get daylight enough, I would shut it out, and trust entirely to electricity.

Even in well-lit galleries things are often difficult to see, impossible to study closely, and this because of the cases. First, as to their placing. It took me no less than an hour and a quarter to find a famous fibula which I knew to be in the Bibliothèque Nationale at Paris (and I knew it quite well by sight) because it was on the dark side of the case (furthest away from the window) though there was room, and to spare, to show everything perfectly, and there was no occasion to place any case so that one side of it was in the dark at all. It is quite a common thing to find the interests of research sacrificed in this way to symmetry. Cases are so placed, in the centre of rooms lit from the side, that things on the far side cannot be well seen; and to look at those on the near side you have to stand in your own light. Not even the artistic effect of the Galerie d'Apollon itself, though the *coup-d'œil* is magnificent, warrants showing things where there is no seeing them.

Cases, place them how you will, are not beautiful objects. No sacrifice to symmetry avails. Why not place them frankly with a view to convenience? That means, in a gallery lit from one side, across the room, not parallel with the side walls, but at right angles to them. The effect of this may be seen in the new gallery of arms and armour at Nuremburg, where the ends of the cases face the piers between the windows. That arrangement leaves room in the shallow window-recesses for table cases. Or, if the cases are very narrow, and the windows wide, for table cases between the upright ones.

This brings me to the question of the cases themselves, apart from their position in the room. Museum cases are nearly always too big—and especially they are much too wide. The idea has been partly, I suppose, to give them importance (the result of having galleries more imposing than comfortable) partly to save ground space. I doubt if it does that, and I positively deny that it necessarily produces a better effect. A larger number of shallower cases might interfere with the vista. But who would not gladly go without that, if

only he could see the things he wants to see? By the way, a sense of proportion leads to making wide cases taller than they need, too, and so interfering even with the vista—as you may see in the Salle Henri II. at the Louvre.

To make wall cases shallower would, of course, mean a sacrifice of room upon the shelves; but that amount of sacrifice is called for in the name of justice. It is not fair to place one thing as a background to another if it reduces it to mere background, as it commonly does. It may not obstruct the view; but it arrests it; the nearer object attracts the eye; and the further one, beautiful as it may be, never emerges into view. That is one argument against deep cases—that the things at the back of them (or in the centre of square cases) are reduced to background. Another is, you cannot get close enough to see things properly. You think perhaps I am making too much of the distance. In a case a yard deep the central objects are only 18 inches off! But it is not the distance that matters so much; it is the intervening glass. When I find things placed just so that a magnifying glass is no use to me (and it is details I want to study), it is not precisely a hymn of praise I offer up to the responsible curator.

And then there are the reflections from the glass which bother one. In a city like London, at all events, glass cases are, I suppose, a necessary evil; but it would be as well to reduce the evil to a minimum; and that means reducing the width of the cases, making them as narrow as possible.

Think what a big vase you can put on a mantel-piece from 9 to 12 inches wide, and you will realise how seldom it is necessary to have cases much wider than that. Eighteen inches are enough to allow of a central division to form a background to things on either side of it. Yet I measured a case in the new Musée des Arts Decoratifs which was a good yard across. When the objects in one of these big cases are arranged pyramidally, there is not even economy of space: the upper part of it is comparatively empty.

In urging the use of quite shallow cases, I am not suggesting any wild experiment. The thing has been done—at Nuremberg, at Munich, at Berlin—and always with perfect success. In the Nordiska Mnseum they divide wall cases on the window side of the room into three, the centre portion, lit from the top, deep enough to hold figures in costume, the wings quite shallow to hold such things as fans, embroidery, and jewellery. Some of the cases at Munich are not more than nine inches deep, and it is astonishing the size of the objects they hold.

Table cases, too, are usually far too deep; and there is absolutely no excuse for putting some things a long way from the glass in order to show next to them others which require a deeper space. In a shallow case it would be so easy to make wells for deeper objects, and in a deep case to raise up platforms for flat and smaller ones—so that everything was as near as could be to the glass, and could be closely examined.

I shall be told that museum arrangement must be a matter of compromise. Personally I don't like compromise, and I think it a very dangerous thing to yield, without a fight, to the necessity for it. But, granting the necessity—and I don't deny it—I would take every precaution against sacrificing anything which was of some account to something which was relatively of none. In so far as one thing must be sacrificed to another, I would begin by dividing things into classes. Let us say: A, things of exceptional account; B, things of great though less account; and, C, things which do not so much matter. It would be a straightforward job then to find places first for the things in class A; then, and not till then, to place things in class B; and to leave things in class C to take their chance when that was done. Some final readjustment would be advisable; and, so long as it involved no sacrifice of efficiency to effect, there would be nothing against it. No one, I suppose, would seriously dispute the contention, that the only justifiable arrangement is one that does justice to the things to be arranged.

There are several topics I should have liked to touch upon—such as the showing of loan collections, the inclusion of modern work in a museum, the sending of national treasures all over the country, and the ways in which museums might be made more helpful to the public than many of them are; but the clock is against me. Happily, many of the expedients which might be suggested by way of facilitating study, have been adopted more or less, though not so generally as might be. The authorities cannot quite realise how badly visitors to the museum want help, or they would do more for them: they are always so ready to give help when you ask for it.

One reason why museums do not interest people as they ought to, is that there are in them so many things which, to the ordinary observer, are not worth looking at. Later, he finds them to be links in the chain of historic evidence, solutions of technical problems, rare instances of workmanship, or in some way or another of very special interest. What a help it would be to him to be told what swans these ugly ducklings were! And a label would do it all. Not the merely descriptive label which says little more than you can see for yourself, but one which tells you all there is to know about a thing—not only what it is, and where it came from, and when it was made, but what there is of technical, artistic or historic interest about it. Only once in my experience — it was at Nuremberg—have I come upon labels boldly pointing out beauties of form or workmanship, and calling attention to details of design, construction, and technique. Students could do with more of that sort of thing. Caution is admirable only so long as it does not quite swallow up courage. Not even a museum director can be expected to know everything. But he is in the best possible way of knowing who does. Besides, a strong man ought not to be afraid of expressing even a doubt, where there is one. Some day the right man would find his way to the museum and solve it for him.

The attractiveness of a museum cannot safely be left out of account in arranging it. There is not much use in a museum no one goes to. It must hold out some inducement. That does not mean to say that everything should be done to make a museum of art and craftsmanship popular. Plan it well, stock it with good things, arrange them in the simple and serviceable way, and it will attract its proper public right enough. We must presuppose in the visitors to a musem some interest in the subject, though not perhaps any great knowledge of it. It may be necessary to prepare people for the right use and enjoyment of what is there. But the arresting of attention and the arousing of interest are the business, not of the museums, primarily, but of the schools, of the teachers of art and craftsmanship, of the very people, in fact, who so often speak of museums as if they were something rather to be avoided than not by anyone with a care for his artistic soul.

I grant you a technical museum is a deadly place until you come to it with a purpose; but it's of no use trying to make it lively. Is there any reason to suppose that people who don't come now would flock to it if it were enlivened with peep shows? or that it would do them very much good if they came? The museum I have had in my mind all along will kindle interest in those capable of taking an interest in it; but its chief business is not so much to arouse interest as to satisfy it. It is no pleasure-place for holiday makers but a treasure-place for people bent on exploration.

Museums of various kinds are wanted by persons of various interests. I am arguing on behalf of one class of persons only, and for a particular sort of museum. We have already a British Museum for the learned, a Wallace Collection for the connoisseur, a National Gallery for the fine artist. Is it too much to ask for one museum at least for the craftsman? And, if it is for him, let it be arranged accordingly.

DISCUSSION.

The CHAIRMAN (Sir Aston Webb, R.A.) said he had seldom heard so delightful a lecture delivered in so interesting a manner. Mr. Day was a gentleman of strong opinions, who did not hesitate to express them. He hoped some of the audience did not agree with them, so that an interesting discussion would ensue. While not saying exactly ditto to everything the author had said, he had no doubt that those present agreed with the greater part of the paper. He thought all would agree with him in a regret that certain people did seem to take a delight in belittling museums. It seemed to him an unfortunate thing that people should say that the contents of mnseums were merely the flotsam and jetsam of art, and lost all their interest when they were deposited there. Even supposing they were the flotsam and jetsam of art, which very likely they were, in the ordinary course they would be obtained by collectors, go through various sale rooms, and by degrees would be almost entirely lost to the nation. At any rate, there was the satisfaction of knowing that, once they were placed in a national museum, they were safe in the nation's possession, and would last as long as human things could last. That was a very great advantage of museums, that it gave a certain permanence to the things which were placed there, and were open for everybody to see and study as long as they lasted. There were two essentials for the proper study of the articles exhibited, the first being the arrangement of the building, and the second the arrangement of the objects, to the latter of which the author had naturally paid more particular attention.

His own attention had been rather more directed to the arrangement of the building. Personally, he thought a museum ought to be placed in an ample space, that there should be some green around it and some gardens if possible, such as the Natural History Museum had, and such as museums, particularly in America, possessed, where the authorities did not hesitate to plant a museum in a public park, to the very great advantage of the museum, and, in his opinion, not at all to the disadvantage of the park. But as a rule the authorities in England did things differently; a museum was placed on the smallest possible site which could be found, and every square foot of land on which the building was placed was used. One excuse for that was that there was not so much land in England as in America, where there was plenty of it, and that made all the difference. Another idea which the Americans had started had struck him as being a very good one in many ways, namely, the grouping of a series of museums in one building, the idea being to have little museums for distinct types; for instance, an Oriental museum and a Western museum with its own galleries round their own court, so that the visitor could go to any part that he required and find a museum of manageable size, instead of, as in the great English museums, the bewilderment and distraction of the huge display which there confronted him. It was too late in the day for the authorities in Englaud to do that very often, but the idea was being developed in a very interesting way in America. The order of the thoroughfares through the galleries, to which the author had called attention, was a very important and difficult question. If there was a very wide gallery of 40 feet, such as in the National History Museum, a central thoroughfare was, he thought, a disturbing element. The space on either side was so wide that people did not know whether to walk down the thoroughfare or to go in and out between the cases on either side. Probably side thoroughfares in that case were better. But in galleries of 30 feet in width, he thought there was no doubt, from a decorative point of view, and also with a view to seeing the objects best, that a central thoroughfare was decidedly the better, and it made it easy for people to find their way about. That brought him to the question of the circulation, which again was an important matter. When people went to museums they seemed very easily worried and troubled. He did not know why, but they did not like to find a dead end in the museum. They resented it very much if they had to pass twice through a gallery where beautiful things were exhibited, and it was a sort of recognised principle, therefore, that it must be arranged that visitors should never pass the same thing twice. That was sometimes rather troublesome, but architects had to face the question. Another provision which had to be made was small escapes for the visitors, to obviate the necessity of their going through the whole of the museum without being able to get out of it when they wished to leave it if they were tired. There was the museum at Hertford House, very ingeniously and cleverly arranged, where there were two circuits, an outer and inner circuit, so that visitors could go round a short way, or, if they liked, could do the whole museum. That was constructed to meet the peculiarities of those people who visited museums. He was bound to say, on behalf of such people, that they frequently wished to leave museums after a short visit owing to the bad air and the want of arrangements for changing air in museums. People got what was called "museum headache" and "museum temper" in a very short time after entering a museum. That was a question for gentlemen connected with his profession to try and avoid. He also thought the galleries should not be too long; they ought to be broken up, and there should be some change in them. Very long galleries, with half a mile of pottery, however beautiful they may be, were apt to pall upon the most enthusiastic; he believed even the author of the paper would get tired of it before he got to the end. He entirely agreed with what the author had said in reference to the decoration of the interior of museums. He thought the less there was of it the better, but the author was kind enough to say that they might have a "blow out" on the staircase and the entrance vestibule, but nowhere else. He entirely agreed with that suggestion. The walls certainly should be absolutely plain. Any attempt at pilasters or decoration of any sort was bound to interfere with the arrangement of the exhibits, and the decoration of the galleries themselves should be the objects which they were designed and intended to contain. He also agreed with the author that the ceilings should be light and the floors dark. If the floors were light, the pattern was reflected very often in the show cases, obscuring the articles in the cases which were on view. Two or three years ago the Americans sent a Commission to Europe to visit all museums. They did so, and catalogued them in the wonderful way in which the Americans did those things. The Commission had also issued a most interesting report with regard to such questions, and also the arrangement of the objects. To anybody who was anxious to study the question, he could not suggest a more interesting book than the report the Commission issued in 1905 containing their observations on all the museums in Europe. He was glad to say they spoke rather well of English museums, Hertford House especially seeming to appeal to them, and also the original part of the Victoria and Albert Museum. The great point the author raised, was whether a museum was for the educated few, or for the uneducated many. He understood the author's idea was that it should be for the educated few; he hoped some of the audience would think it ought also to be for the uneducated many. Mr. Day did not like compromises, but he (the Chairman) was afraid that in this world it was impossible to get on without them. He confessed he was one of those weaklings who thought that, in regard to museums, it was necessary to cater for the expert,

like the author, and also for the man in the street, like himself. He had occasion to make a tour through nearly all the museums in Europe, making the trip for the purpose of endeavouring to obtain information. He had introductions to most of the directors of the museums; but when those gentlemen took him round they always impressed upon him the fact that they were following exactly what was done at South Kensington. They said, "These cases are just like what they have at South Kensington." He replied that he wanted to see what they were doing of their own initiative. That fact was a very striking one, and it was a great compliment to the authorities at home. Any visitors who went to Germany, or any other country in Europe, would find that what he might call *bric-à-brac* museums were very much founded throughout on the great one in England, which was the father of them all. The Zürich Museum was almost entirely composed of rooms; and having seen it, if Mr. Day had not been present he should have confessed he was rather pleased with it. He quite saw the author's point, however, that it was a popular, and not a scientific way of arranging things. He was glad to hear the author say, however, that he did not object to a few of them. How far the objects should be shown in their surroundings, was a matter for experts, which he had no pretension whatever of being. Everybody knew the celebrated instance of Rembrandt's "Night Watch," in Amsterdam, which originally, he believed, was hung in a club smoking-room, and after being smoked upon for years derived a beautiful rich colour, like old pictures did. It dominated the whole room, and was a glory to everybody who went into the place; they were filled with amazement at the wonderful picture which was hung at the end of the room. He had heard Sir Alma Tadema describe it in glowing terms. When the Ryks Museum, which the author had described, was built, a very large gallery was made, and at the end of it, the most important place in the whole museum, a space was left for the "Night Watch." It was common knowledge that when that picture was put up it was a great disappointment; no one could believe that it had the wonderful power which it possessed when it was hung in its previous position, with the resnlt that a special room had to be built for it; and when it was removed from the large gallery and put into it, it again took the place it had occupied before as one of the works of the world. In that case the surroundings obviously affected the picture; but he understood the author to say that that did not much matter, because visitors wished to see how the thing was done, and not so much the effect of it when it was done. He quite understood what Mr. Day meant, and agreed with him to some extent. With regard to the question of the arranging of the objects themselves, he did not think the general decorative effect of the gallery could be overlooked. With pictures and furniture it was necessary to think, to some extent, of the general appearance. Although he was not an expert, he should imagine it was quite possible to arrange a gallery in a decorative way, and yet not to sacrifice any of the technical beauties of the articles shown. Everybody agreed that light was everything. Most museums were too dark, and future museums ought, if anything, to be too light. If that was done, some of the light could always, if necessary be cut out, but if the means for the entrance of light were not present, it could not possibly be increased, except as the author had suggested, by electric light, which he did not think would be very satisfactory. He was not quite sure that white walls were the proper thing for showing old objects in the best manner, as with old furniture and other old articles it would show too plainly their state of decay. Personally, he thought a darker background would make them look a little more at home, and a little less like the flotsam and jetsam which had been referred to. He was not quite sure that sentiment need be abolished out of museums altogether. There was, he thought, a great deal of sentiment in going into a fine museum; one felt the effect of those great men who had departed, and who yet lived again by their works, which could be seen. He felt on such occasions that the finest part of them was still alive, and that one was still able to see it in passing through the galleries of a museum. It was a very inspiring feeling to anyone who entered a well arranged museum, and should be an encouragement to every student, old and young. He had always felt, as Reynolds had said, that the works of those who had stood the test of ages, had a claim to that respect and veneration to which no modeın could pretend.

Mr. A. B. Skinner thought that a good many of the pictures of the rooms which the author had thrown on the screen were in national museums and not in art-industrial museums. He recently had an opportunity of seeing the Art-Industrial Museum at Cologne, which the author had described, and he knew of no museum which approached his idea of what a provincial museum should be, better than that one. The director of that museum, Dr. Von Falcke, had now reaped the reward of his labours, having been appointed the director of the great Kunstgewerbe museum at Berlin, where he would take up his duties next April. There was only one small furnished room in the Cologne Museum. At Frankfort, where was a new art-industrial museum, there was no furnished room, as far as he could recollect. As a fine type of a national museum he mentioned particularly the one at Zürich, which illustrated the past history of the Swiss by means of furnished rooms and the manner of living, right away down from the earliest to the present time. The rooms at Zürich, however, were distinctly different from the pictures of the rooms which had been shown on the screen, in that they were not crowded with furniture. There was a certain amount of furniture in them, just sufficient to show, but they had not that mass of objects about

them which was a prominent feature of the illustrations of the rooms thrown on the screen. He did not care very much for rooms which were crammed with tables with plates and pewter on them, and chairs, but a certain number of such rooms were very useful no doubt to show the manner of living of people in days gone by. He thought there should only be just sufficient furniture in the room to show its relationship to the panelling round the room. The author had given him some information he did not know before, namely, with regard to the narrow wall cases in the Munich Museum. A visitor to a museum naturally wanted to have the object near to him, and if two objects were put into a case, one behind the other, one might form a background to the other and would not be seen. The last thing in museums was the Kaiser Friedrich Museum in Berlin, which was opened a few years ago, and if any information with regard to that museum could be given by any of audience he thought it would be extremely useful. He believed the background there was made of a kind of canvas, but he fancied that substance would not stand the climate of London; it would be dirty in a winter and would then not be fit to be seen. He sided with the Chairman against the author on the question of compromise. There must be compromise. Everything possible would be done for the craftsman and for the designer, but it was necessary to interest those people who came to see the objects, and no doubt rooms furnished to the extent to which he proposed they should be furnished did interest them. He presumed the paper did not deal with historical museums, the real museum to which the author had referred being the Kunstgewerbe Museum, where history played a small part. The objects were not bought for that purpose, but purely as examples of technique and for the beauty of their workmanship and so forth. He thought they were getting out of the idea of the highly decorated court such as might be seen at the Crystal Palace, but had rightly got into their minds the fact that it was not necessary to decorate the rooms of a museum, but that the objects should decorate them. If the walls and rooms were kept quite simple, the objects could be seen without any distraction. The first room at Zürich had troubled him very much, as it had been painted to the best of the ability of present day painters to represent an historical room and, it seemed to him, unpleasant in appearance. Light in a museum was a most important thing, and in London especially so. The question of light must be very carefully studied in every museum built in the metropolis. He went recently into a museum not a thousand miles from the Society's rooms, and although the day was foggy, the arrangement of the windows was such that the interior of the musuem was really quite light. He expressed his very grateful thanks to the author for the paper he had read.

Sir GEORGE WATT, C.I.E., said that he had spent over thirty years of his life in India, and it was his duty at one time to have to arrange one of the museums in that country. He was then confronted with many of the problems that the author had dealt with. He had had placed at his disposal a building, built north and south, one side of which was almost entirely composed of glass from the top floor to the bottom. The tropical Indian sun poured in through the great glass windows all day long, so that that museum had plenty of light. He tried to subdue the light rather than to admit more, because everything was bleached in a very short time, the fabrics being entirely ruined by the action of the light and heat. He had to fit up and arrange the collections as an industrial museum. For a good many years prior to his taking charge of the work a very large collection had been made of various articles, and he was confronted with the problem of how to classify and arrange them to best advantage. The educational basis was to be industrial, and therefore he had to appeal to a special community. He accordingly proceeded to divide the museum into three sections, (1) industrial arts, (2) economical and commercial, and (3) ethnological. He had many thousands of objects which had to be grouped and displayed. He adopted as a classification a very material one; he made the basis of his system the materials of which the things were made or for which they could be used. He had no doubt Mr. Day and other gentlemen present would laugh him to scorn for having attempted such a standard, but at the time he could not discover a book which appealed to him as affording a classification that seemed to him to meet the purpose in view. He commenced, therefore, in the commercial section by having a portion devoted entirely to timbers, another to metals, to stone, &c., and these were arranged in the ordinary way. He had some shallow cases three inches deep made for the purpose of lining portions of the walls; into these he put all the objects obtained from the trees, such as the gums, fibres, &c., also botanical specimens, drawings of the flowers and maps of parts of India showing where the various trees were found; and the woodwork of all the cases was made of the timber of the trees in question. He had also logs of the trees assorted here and there, cut off at different angles to show different sections of the timber, and numbered and named in a particular way. On the next floor immediately below the same system of numbering was used, and by following the numbers and names it was possible to see the cartwheels, the carved woodwork, and other objects made of the timber. Going lower down to the next floor, into the ethnological gallery, visitors could see such things as bows and arrows, agricultural implements, machinery and appliances that were also made of of these various timbers. A visitor could thus carry his inspection of the museum from one floor to the other through all the three sections into which it was arranged. When he came to arrange the textiles he thought of dividing them into dyed fabrics, woven patterns, embroidered patterns and so on, but that was not enough. He

desired to arrange the textiles on some sort of basis which seemed to him to be instructive. With that object in view he obtained specimens of all the needlework he could find, and tried to discover the different stitches of the work. He applied the knowledge he thus obtained to the Indian embroidered fabrics, but found they were in many directions different from that of Europe. On consulting his lady friends he soon saw that they could not enlighten him very much, so he went to the natives, who showed him how they did their embroidery. At first he thought he had got on very well, but very soon found he was hopelessly at sea for a very important reason, namely, that his lady friends had taught him to use a needle in the European way, whereas the natives did their embroidery in exactly a reverse way. After a great deal of study, he came to the conclusion that the museum of embroidery had better be arranged according to the stitches the natives used, and when the museum was completed it proved very interesting to those who visited it. He thought it would be very instructive if Mr. Day would follow up his present paper with another dealing specially with the systems of classification. In the commercial portion of the Indian Museum, he endeavoured to show the history of the objects, not from an historic but from an industrial point of view, showing where the materials came from, where and how they were worked up, and the different stages in the manufacture. Taking, for instance, lacquer work, he showed first of all the timber, then the turned article, then the various stages of lacquering, etching, and painting the lacquer work until the completed article was seen. He thought a museum of that kind, if it were properly arranged, could be made exceedingly interesting. He had gone through most of the museums in this country and of Europe but was egotistical enough to think they did not meet the purposes—necessities of industry and commerce. They contained too many glass cases and bottles, and were far too technical. He wanted to see in a museum something that would instruct the artificer and the trader. In his opinion, a museum should be primarily for the man in the street, scientific visitors should not come to public galleries at all. They had no business there; they should be in the research room, or special galleries, where specimens were stored and arranged in the most economical way for research. He thought many of the English museums could easily be made more attractive and educational than they were, the commercial and industrial side having been neglected to a very painful extent. He had enjoyed hearing the paper very much, and had greatly benefited by it.

Mr. Edward Packard said he had attended the meeting for the purpose of learning how a provincial museum could help forward the cause of arts and crafts. He was the chairman of the museum committee of a provincial town, which established one of the first museums that was ever opened in this country, namely, in the year 1844. So far as it went they had an excellent natural history museum, and special attention was also paid to the department of geology, because of the redcrag which abounded in the county. With reference to arts and crafts, they had from time to time picked up bits of carved work, and got together a fair collection. Curiously enough, the only handicraft work which was attempted to a reasonable extent amongst the people in his district, was carving, and there were students in the carving classes, who made use of the examples contained in the museum. He would be exceedingly obliged if the author could give him a few hints as to the best direction which should be pursued in classifying and organising exhibits to help forward handicraft work. Unfortunately, they had not much money, which was one of the difficulties of all museums, especially museums in the provinces, and it was not easy to do all that one desired, for that reason. He was particularly desirous, however, of helping the art schools to obtain such examples as might be particularly useful in a country town.

Mr. Arthur H. Smith desired to support Mr. Skinner in the remarks he made with regard to compromise. In a museum everything was a question of compromise. First of all, it was necessary to compromise with the past history of the institution under discussion, which perhaps went back for hundreds of years; it was necessary to compromise with the legacy of the architect, who had perhaps erected the building which was used as a museum, for some totally different purpose; then again it was necessary to compromise between the different purposes for which the museum existed and the different people for whom it existed. As one speaker had justly pointed out, the best thing would be to withdraw most of the objects. The uninstructed person only required a few important and typical objects. It was all very well to tell students that the rest were accessible to him if he would only ask to see them, but at the same time he was discontented if he did not have a few things put out for his benefit. The real difficulty was that it was impossible to have unique objects in duplicate still less in triplicate, in which case they might be placed according to different points of view. Again, it was necessary to compromise with the limitations of human capacity on the part of those who had to take charge of the objects in question. If he understood the author rightly he would put all the fine bronzes in one place and other groups of objects in another place. The result would be either that everybody must have a knowledge of everything which was no longer possible, or there would be an inextricable mingling of curators, each taking care of everything. Taking such a detail as the glass cases, if the authorities had an infinite amount of money at their disposal, if the objects were perfectly stationary and the collection did not change, the cases could be made to fit the objects. But sup-

posing it was necessary to shift the objects, if the article was large and the case was small it would not go into it. That was got over to a certain extent by having cases of a standard depth, and bringing the background forward by means of fittings, but there it was necessary to compromise between the person who wanted to use a magnifying glass and the person who wanted to look at the things generally without being disturbed by the reflections in the glass. The question whether exhibits were difficult to see on account of the reflections depended upon whether the eye, while looking at the objects, was also in focus for the glass case. The whole of the management of a museum must be a compromise, and therefore it was necessary to make the best compromise possible.

Mr. W. COLDSTREAM stated that he had taken an interest in museums all his life. He was first concerned in the preparation of the specimens for the Hall Museum in 1864, while recently he had been in charge of the galleries in the Indian Section of the Imperial Institute. He thought it was very important that the literature in all museums should be in very distinct terms, pointing out the direction in which those who were interested should proceed to find the subjects for which they are searching. It was very desirable that there should be a plan in each museum. in fact, ground plans should be hung on all the walls throughout the museum, pointing out where those interested could find the object they required. Another necessity was that the cases should be distinctly labelled, in addition to large hanging labels describing the various classes of the exhibits. It was of the utmost importance that there should be in the cases, alongside the articles, plain and easily read descriptions of the scientific, technical, or commercial value of the articles. It was also exceedingly desirable that easily accessible handbooks should be scattered about the museum. At the Imperial Institute, the plan was adopted of putting Sir George Watt's exhaustive monumental work on the products of India, in small cases on the walls, but it was found necessary to chain the volumes in order that they could not be removed. It was most desirable that literature, although not of quite such an elaborate and technical nature as Sir George Watt's book, should be placed within the reach of those who visited museums.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Day for his interesting and instructive paper.

Mr. DAY, after acknowledging the kind way in which the audience had received his paper, said the only thing which had been seriously objected to was his protest against compromise. But he had not denied the necessity of compromise. He had only said he did not like it. And he did not think they should yield to it without a fight. One had to arrange a museum, like everything else, upon a principle. If a man was prepared to fight for that principle all through, then he would not make a compromise that he was ashamed of afterwards. If, however, he was ready to compromise at once, he would not do more than a middling thing in the end. That was his conviction. He admitted, however, the necessity of compromising in a sense all through. The Chairman had misunderstood him with regard to the white background for old furniture. He had expressly stated that it was necessary to have a colour which would, so to speak, pull the things together, but that above them, say 9 feet from the ground, the wall might be white so as to get as much reflected light as possible. The real point at issue was as to whether a museum should be arranged for specialists, and students, or for the man in the street. He entirely agreed that it should be for the man in the street—such as the Chairman confessed himself to be. He did not mean to say the museum should be a resort only for specialists, but that it should have a special purpose. And the man in the street would, if he only knew it, benefit much more by having a museum which was arranged for a specific purpose of instruction, than something arranged simply for the purpose of amusing him. It was not, therefore, any injustice to the man in the street to arrange a museum for study. The man in the street, too, included the workman, and it was for him that the museum ought to cater, not merely for art students. The man who would most benefit by a museum often did not go to it because he did not find there what he wanted in the form in which he wanted it. That led him to the question of what had been asked, of how he would exhibit a handicraft. He would simply arrange it in order so as best to make it intelligible to the handicraftsman. Of course, the particular order depended upon the particular craft. His suggestion would, by no means, end in putting together all the fine bronzes or anything else. He would not put all the fine things together; he would put the things in the sequence of the handicraft, and he would have things so arranged that anyone who was interested in a particular thing could go to the museum, see the thing he was interested in, and trace it from its simplest and most rudimentary form up to its very highest. That would certainly not mean putting all the fine things together. With regard to rooms, he quite agreed that if the museum authorities could get hold of a few good rooms they would be most useful things to show, but they would not get many. The thing he protested against was the making up of rooms and arranging things in that form in a museum. It was quite true, as Mr. Skinner said, that the museums to which he (the author) alluded were not always technical museums, but national museums; but the idea of pretty rooms had fascinated most people in a way that he thought it should not. He had, therefore, protested against the object-lesson, which, he repeated, he thought was more fit for the kindergarten than for a national museum.

CANTOR LECTURES.

THE THEORY OF THE MICROSCOPE.

By Conrad Beck, F.R.M.S.

Lecture III.—Delivered December 9, 1907.

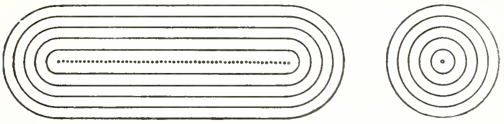
The Errors of a Microscope Due to Diffraction.

Syllabus.—General explanation of diffraction—Diffraction at a slit—Diffraction in a converging cone of light—The diffraction pattern or antipoint—Influence of the antipoint on the image produced by a telescope—The conditions that regulate the size of the antipoint—The Abbe theory of microscopic vision—Weak points in this theory—J. W. Gordon's attack on the Abbe theory—The antipoint as influencing microscopic images—The advantage of the oil immersion—Relation of aperture to magnifying power—J. W. Gordon's methods of reducing the size of the antipoint—Limits of visibility—Limits of resolution—Shapes of antipoints formed by different shaped bundles of rays—Resolution of rulings by special illumination explained—Diffraction in the eye—The Ramsden circle as a measure of aperture.

In our first lecture, the problem of making a microscope was investigated by discussing the means whereby an enlarged image of an object could be obtained by combinations of simple lenses. In the second lecture it was shown that simple lenses produced enlarged images of such bad quality that much of the advantage of the enlargement was neutralised. The methods by which the errors of simple lenses have been almost completely removed was outlined, and the problem of forming perfect enlarged images had apparently been solved, but there is another element which enters into the question, and forms a serious restriction to the development of the microscope. Diffraction due to the interference of light seems, so far as can at present be predicted, to place a final limit upon the magnifying power that can usefully be obtained with a microscope. This lecture will be devoted to a consideration of that point.

In elementary works on optics, it is stated that light travels in straight lines. It is true that if an opaque object be placed between a candle and the observer's eye, the light does not go round the obstacle and the candle is obscured, but the statement considered as a bald fact is essentially untrue. A single particle of ether when caused to vibrate by reason of a light impulse, has no greater tendency to communicate its motion in one direction than another. A stone dropped into water communicates the disturbance in all directions, as shown by the circular waves, which travel outward from the point of impact, but a row of adjacent stones dropped into the water will not form a series of circles arising for each stone. The wave created by one stone has a certain influence on that of its neighbour, and the result is that as far as the central portion of the row of stones is concerned, a straight wave travels outwards and the vibration proceeds in a straight line direction. Such is also the case with light, a body of light travels in straight lines not from any quality of its own but because each individual ray, although it has a tendency to wander in all directions, is kept in a straight course by the influence of its neighbours on either side. Its endeavours to travel away from a straight direction are frustrated by similar but opposite endeavours on the part of its immediate neighbours, and at the margin of

Fig. 40.



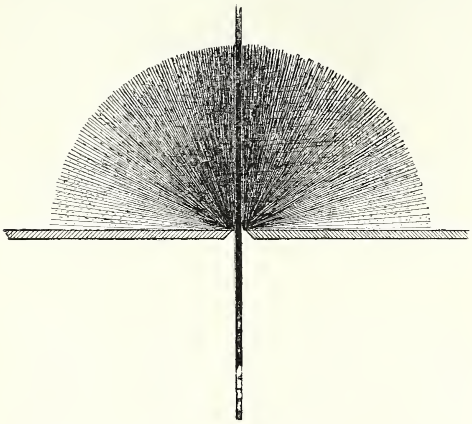
the row of stones where upon one side no neighbours exist to regulate the couduct of the edge rays, these do not travel only in the direct line of propagation but send off vibrations in the form of a fan.

This phenomenon is called diffraction and the light which does not travel in the direction of propagation is called diffracted light.

The statement that light travels in straight lines and the conception of diffraction as a supplementary phenomenon is a clumsy and inaccurate method of expressing the case. The facts are more truly stated by saying that light travels in all directions, but that when a sufficient body of light is considered it travels in only one, because each individual ray is so controlled by its neighbours that all except the margin moves in one direction. The diffraction of light explains why the edges of a shadow are never perfectly sharp, but there is always a fuzzy outline caused by the diffracted light which spreads into the pennumbra. An X-ray photograph of, for instance, the bones of the hand is nothing more than a shadow made by X-ray light, and to those who have tried to photograph the shadows formed by ordinary light, the brilliancy of the definition of the X-ray photograph is surprising. It is due to the fact that the X-rays have no perceptible diffraction, and, therefore, a perfectly clear and defined shadow is produced.

In large beams, where there are many elements to regulate the behaviour of the community, the relative amount of diffracted light is small, but as the beam is narrowed it rapidly increases. If an exceedingly fine pencil of light is obtained by passing it through a narrow slit (Fig. 41), the amount of

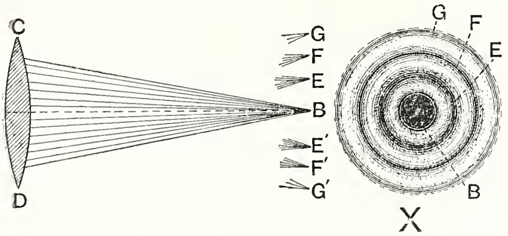
FIG. 41.



spreading out is so great that instead of proceeding as a fine feather in the direction of propagation it spreads out in the form of a complete fan.

Diffraction is here demonstrated in an extreme form; the indistinctness of the outline of a shadow shows it in a lesser degree. If the converse of a shadow be considered, a similar result will be observed. Suppose the lens C D (Fig. 42) to be a telescope object-glass forming an image of a distant star at a

FIG. 42.



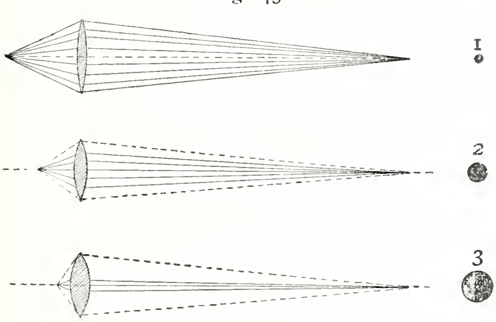
point B. On the methods indicated in the last lecture the lens may be assumed to be so corrected as to refract all the direct un-diffracted rays included in the cone C B D to an exact point at B, but there is a certain proportion of diffracted light being given off as a haze from the aplanatic beam which will form a halo around the point and prevent the image of the star from being a clean cut point picture.

This halo, emerging from the envelope of the cone C B D, spreads out in a mist which might be expected to be uniformly distributed, but that is not so, for the individual portions of this mist influence their immediate neighbours, and a statement as to the behaviour of the whole body would be as tedious and voluminous as the narrative of all the incidents occurring to a large army on the march. Its condition, however, when it arrives at its destination is more easily ascertained, and is in fact the question which is of importance. Its destination is the focal plane at B, in which the image is formed, and it can be found both by calculation and experiment, what is the nature of the light when it arrives upon a screen placed at the position B. It is in the form of a pattern, the size and shape of which will depend on the nature of the beam of direct light from which the diffraction has originated, and the shape of this pattern is of great importance when considering the question of image formation. If the image of a point is being formed by a beam of light which is a solid cone as in the figure, the pattern will consist of a central disc of light surrounded by a series of rings of varying intensity, brightest near the centre. If it is formed by a beam of light which has the shape of a flat feather the image, although the object itself is a point, will consist of a central bar with a series of parallel bands of either side. This diffraction pattern of the image of a point of light formed by an instrument has been called by Mr. J. W. Gordon an antipoint, which is a convenient term, and one which I shall henceforward employ in describing it. Having ascertained the antipoint formed by a particular instrument, the image that it will produce of any object no matter what shape is obtained by supposing every point of the image to be replaced by an antipoint, and we may confine our attention to the antipoint in order to arrive at the image-forming qualities of the instrument under investigation as far as diffraction influences it. Every image formed by lenses such as a photographic lens, a telescope or the human eye is influenced by diffraction, each point in the object is represented in the image by a diffraction pattern or antipoint. In such instruments as photographic lenses the antipoints are generally so small, and therefore so nearly points, that their effect upon the resultant picture need not be considered, but in the telescope, where the image is highly magnified, the form of the antipoint has an important effect on the quality

of the picture. In the case referred to (Fig. 42) of an image formed by a solid circular cone of light when the antipoint consists of a central disc brightest in the centre and gradually shading off to blackness, around which is a fainter ring of light increasing to a maximum brightness and shading off again to black, there will be beyond this a second much fainter ring, and if the image be sufficiently intense a third, fourth, and fifth ring can be observed, in each case of less intensity than before. The rings under ordinary circumstances are so much less brilliant than the central disc that they have little or no perceptible influence on the image, and attention may be confined to the diameter of the central patch or disc. It is evident that the smaller the disc the sharper the image, and it is important to ascertain what is the factor governing the size of this disc.

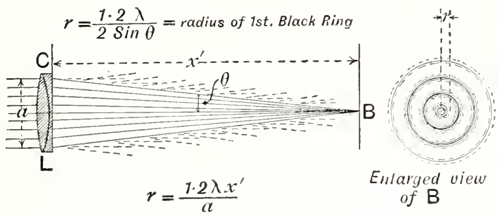
Recollecting the cause of diffraction, namely, that rays of light travel in direct straight lines only when there is a sufficient body of them travelling together, it is evident that the greater the number of rays there are the less is the proportion that wanders off from the direct course, and the less will be the diffraction. Thus a large cone of light as at Fig. 43 (1) has little diffraction and produces a small disc image, a small cone of light as at (2) or (3), will have great diffraction and produce a large disc.

Fig. 43.



Now, although the bright and dark rings may not generally affect the image itself they are useful in measuring the size of the central disc, because the larger the diameter of the rings the larger will be that of the central disc, and the central disc which shades off from light to black has an indistinct outline and is difficult to measure. The most convenient portion of the diffraction pattern by which to determine the diameter is either the first black or the first bright ring. The diameter of the first dark ring may be considered as being about double that of the visible disc seen with ordinary illumination. This diameter is expressed by the formula (Fig. 44) $r = \frac{1\cdot2\,\lambda}{2\sin\theta}$ where r = semidiameter. This may be written $r = \frac{1\cdot2\,\lambda\,x'}{a}$ where x' is the distance of the image from the lens and a is the aperture.

Fig. 44.



From this formula as from the consideration of Fig. 43 it appears that the larger the aperture (a) the smaller will be the diffraction disc or antipoint. Thus it is of great importance in instruments which, like the telescope, form magnified images, that the bundle of light should be as large as possible, and that the size of the object-glass should be as large as the other considerations will permit so that the image is formed by large cones of light.

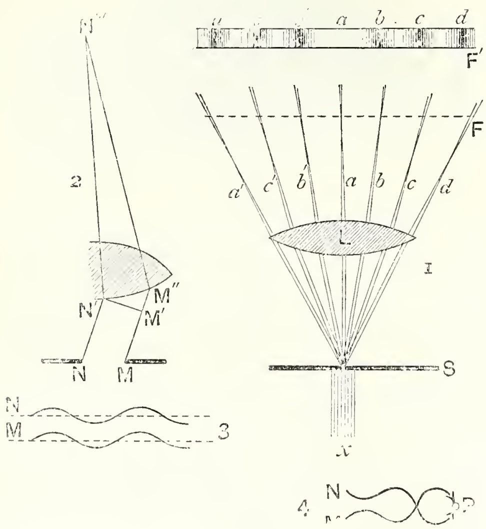
We have so far referred to this question as applying to optical instruments other than the microscope, because Frauenhofer stated that the ordinary diffraction phenomenon could not be applied to high power microscopes on account of the fineness of the objects being observed, and that no pair of objects situated at a closer distance than a wave length of light could ever be seen as more than one object; but as early as 1827 Sir John Herschel observed in criticism of this, that it is "a conclusion which we cannot regard as following from the premisses." Nevertheless Frauenhofer's statement seems to have been generally accepted, and when two objects which were closer together than a wave length of light had been distinguished with a microscope, some explanation was required to account for such a phenomenon.

This explanation was given by the extremely elegant Abbe theory of microscopic vision which is probably one of the most attractive and ingenious optical theories ever advanced. I propose to briefly refer to this theory, and the proofs upon which it rested, and then follow some of the work of Mr. J. W. Gordon who, in the last few years, has demonstrated

that the Abbe theory, in spite of its extreme beauty of conception, rests upon insecure foundations, and that the ordinary diffraction theory of other instruments may probably be applied to the microscope in a similar manner as it has been to the telescope, which was indeed hinted by Sir J. Herschel.

The Abbe theory pointed out that objects as fine as those which are observed with a high power microscope, split up the light which illuminates them into finely divided bundles of

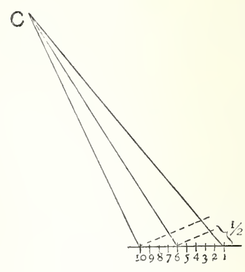
Fig. 45.



rays of light, each bundle consisting of a direct aplanatic beam and a fringe of diffracted light. To explain the point, consider a transparent line in an otherwise black field, which is represented in Fig. 45 (1) in section, illuminated by a parallel bundle of light, X. The light, after it has passed through the aperture formed by the transparent line, consists of a direct bundle of light, surrounded by a complete fan of diffracted light. It is only a convenient method of expression to call the light (*a*) direct, and to call the other portions of the fan diffracted light. It is all of exactly the same kind, but has ceased to travel in a direct course, and has been spread out into a fan. If a lens, L, be placed so as to collect all this light, each bundle of parallel light from the slit will be brought to a focus on a surface in the focal plane of the lens at F, and a screen placed at F will show not as might be supposed an evenly illuminated bright surface, but a series of bright and dark bands of light as shown at F′. By investigating the light that reaches the centre of one of these dark bands as C, the reason for this darkness is explained. It is due to the same causes which produce the straight line propagation of light and the diffraction patterns of focussed beams in optical instruments, but the cause can be more readily demonstrated in this simple case.

Fig. 45 (2) is an enlarged diagram of a portion of Fig. 45 (1) showing at N‴ in section the centre of one of the black bands on the screen placed at F. The whole of the light that can reach the point marked N‴ is included in the beam N, N′, N‴, and M, M′, M″ N‴. Now if we consider the two boundary rays alone it will be seen that if the length of the ray N, N′, N‴ be compared with the length of the ray M, M′, M″, N‴, the latter is longer than the former by the amount of M′, M″,* and that this difference will vary in length according to the obliquity of the bundle of light selected. Suppose that the distance M′, M″ is equal to half a wave length of light, and that the rays N and M started from the aperture in the same phase as Fig. 45 (3). When these two vibrations meet at the focus at N‴ they will impinge upon the same particle of ether as shown in Fig. 45 (4); but one vibration having travelled half a wave length further will be half a wave length in advance of the other; thus the vibration N will strike the particle C with a tendency to force it upwards, and the other, M, will strike it with an exactly equal tendency to force it downwards, and the two vibrations will be neutralised, thus extinguishing the light and causing darkness. That is what happens as regards a pair of separate rays, but the image is here formed by a small complete bundle, and if we suppose such a bundle to consist of, say, 10 rays close together, as at Fig. 46, and

Fig. 46.



if we suppose the distance 6, C, is half a wave longer than the distance 1, C, then rays 1 and 6 will cancel each other; again, the rays 2 and 7, 3 and 8, &c., will cancel one another,

* In the figure N N′ is supposed to be equal to M M′, and N′ N‴ equal to M″ N‴. The fact that the diagram is not very accurately drawn does not affect the argument.

so that if the distance in length between the marginal rays 1 and 10 is equal to one whole wave length, the entire bundle will cancel one another, and a black image will be formed. Thus the position where a complete bundle of rays will entirely cancel one another will be where it is at such an angle that the two marginal rays differ in length by one complete wave length.

Now, what does the phenomenon of the dark bands on the screen placed at F mean, not that there is any difference in the light given off from the fine slit, but that there is a certain small bundle of light at a particular angle, *b* (Fig. 45), that will be extinguished if focussed to a point. There will be another at an angle, *c*, which will also be extinguished, because its marginal rays have a difference in phase of two wave lengths, another three, and so on. Thus this fine slit when focussed through a lens produces a definite diffraction pattern of dark and bright bands. A change in the nature of the slit will produce a change in the nature of the diffraction pattern, and the character of the diffraction pattern formed at F, although it is not a *facsimile* of the slit, grating, or object which gives rise to it, is partially determined by the shape of that slit, grating, or object; under some occasional circumstances it reproduces the pattern of the object, but has usually no close apparent resemblance. Figs. 47 and 48 display a series of diffraction patterns produced by different kinds of apertures and by the same object, a point of light, showing that although there may be a connection that can be calculated between the object and diffraction image, there is no direct resemblance between them, and the same object, namely, a point of light, may produce many patterns, or, if we take the converse case of objects of different shapes, which are viewed by light focussed down by a lens, the same dissimilarity between the object and its diffraction pattern may, and generally does, exist. Now assuming, as Frauenhofer did, that optical instruments could not produce pictures by ordinary refraction of objects smaller than a wave length of light, when it had been shown by experiment that such pictures were undoubtedly produced, it occurred to Abbe to consider whether the objects themselves did not produce their own pictures by means of the interference just described. Fig. 49 illustrates the formation of black interference images formed by a grating. On a screen, placed at F F, is displayed a series of bands, each, to some extent, a rough image of the slit. If all the light, forming these images, be again combined into an image in the picture made by the microscope, an image, more or less resembling the grating, might perhaps be formed, even if a direct shadow picture of the slit could not be made by the optical instrument. It would appear that on this theory, the picture seen in the microscope is in part formed by aplanatic or dioptric bundles of rays (not shown in the figure) which form images in the usual way, which images were supplemented or modified by diffraction patterns, having a resemblance to the object being observed.

FIG. 47.

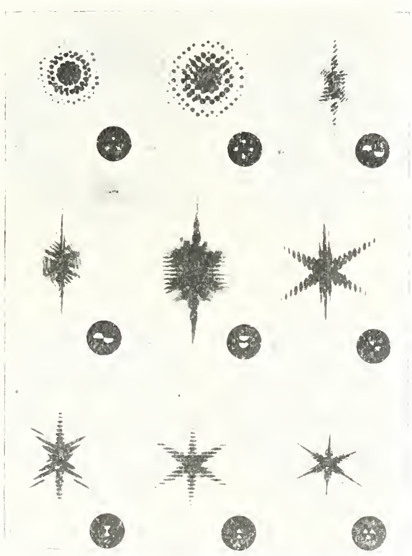
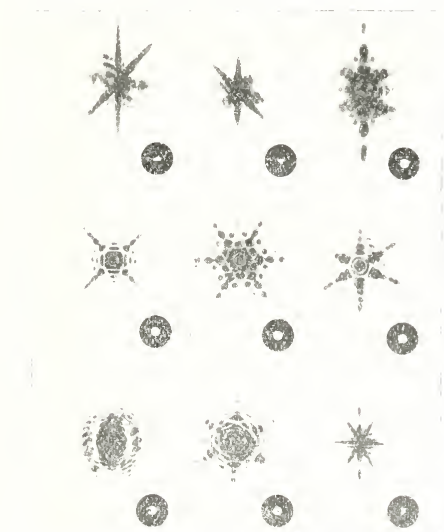


FIG. 48.



In fact, it would appear that the diffraction produced by the object itself was the determining factor of microscopic resolution, although the reason why such diffraction patterns should necessarily closely resemble the objects which give rise to them has never been discovered and would appear to have no existence.

By this theory a limit for the resolving power of the microscope was established, namely, that in order to resolve details of a certain fineness the object-glass must be capable of collecting a sufficient angle of light from each point of the object to embrace at least one diffraction beam capable of forming an interference or diffraction image, as for instance the beam, C C, in Fig. 50. Referring back to Fig. 45 (2) it is evident that if the object represented by the slit, N M, were smaller than shown in the diagram, the distance, M′ M″, would be smaller and would not be equal to a wave length if light, and that the rays which would have this necessary difference in length to form the first diffraction image would be those at a greater obliquity, so that the first black band might be formed more nearly at *c c′* than at *b b′*. It followed from this that because with a finer slit the angle at which the rays, capable of forming this diffraction image, were given off was great, a lens to show fine detail must have great angular aperture to collect them, and that the limit of image formation would be reached when the object was so fine that the first bundle of such rays was emitted at an angle of 180°. A further advantage, however, could be gained by the homogeneous oil immersion system, when the whole space between the object and lens was filled with refracting media. These media reduce the wave length of light, and consequently the angle required to obtain the necessary interference condition need not be so great, and finer detail could be shown by the same angle. Reference to Fig. 45 (2) will show that if the distance, M′ M″, which must be the length of a wave length, need not be so long, the diameter of the slit, N M, may also be smaller, and the same angle of light will produce the same interference figure at N‴ of a finer slit. Thus an absolute limit is set by the Abbe theory to the resolving power of the microscope as soon as the highest possible refracting immersion medium had been used, and an angle of 180° of light had been collected by the microscope. This theory was accompanied by a very attractive experimental proof. A grating of fine lines, Fig. 50 (1), was placed on the stage of the microscope, illuminated by a beam of parallel light. An object-glass was employed capable of collecting light of sufficient angle to include the bundles capable of forming diffraction images *b b*, *c c*, *d d* (Fig. 45), of the 1st, 2nd, and 3rd order. A series of special diaphragms was inserted behind the object-glass, and the effect of cutting out different portions of light was investigated. It was shown that a diaphragm that had a small slit cutting off all but the direct aplanatic light rendered the grating structure invisible which had been previously shown clearly resolved, Fig. 50 (2). A diaphragm, consisting of slits which allowed the

FIG. 49.

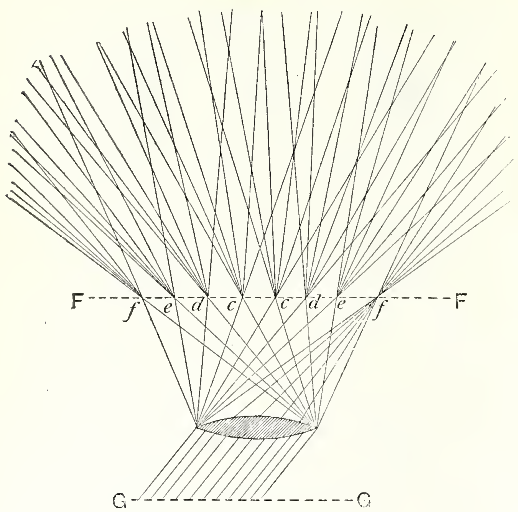
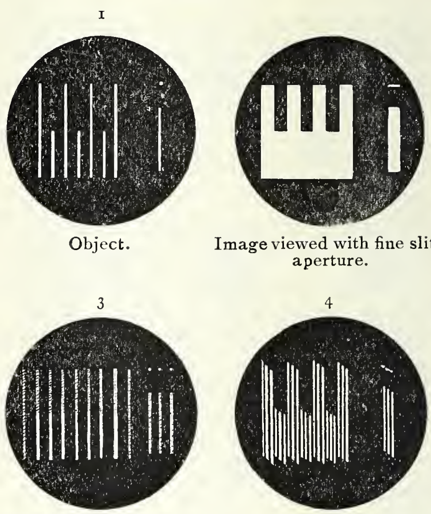


FIG. 50.



Object. Image viewed with fine slit aperture.

Image viewed with triple slit aperture. Image viewed with triple slit aperture rotated.

beams of light *b b*, *c c*, *d d*, only to pass, allowed the grating structure to be seen, and, what was more curious, if the diaphragm introduced consisted of slits which excluded all the light except the alternate diffraction images *c c*, excluding the image *b b*, *d d*, it made the grating appear in the microscope to be double as fine as it really was, Fig. 50 (3). Now a grating double as fine would have produced images at *c c*, (Fig. 45), and none at *b b*, *d d*; thus the diaphragm artificially produced the diffraction images that would have been formed by a finer grating, and this having been done, the image of a fine grating was actually seen in the microscope. A proof was apparently established that the image formed in the microscope depended purely upon these interference images caused by the object.

The validity of this proof was contested to Dr. Clifford Mercer in 1896, and was more completely investigated by Mr. J. W. Gordon in 1901. Mr. Gordon explained that the results obtained by the above experiments could be shown to be due to the diffraction effects caused by the diaphragms employed to cut off different portions of the light. I will repeat two of the experiments in the lantern, which are similar to those described by Professor Abbé on the microscope. I have in the lantern a double grating, with two sets of lines at different distances; to the right of these is a single line and a point, Fig. 50 (1). By now introducing a very small slit, the structure of the grating disappears, Fig. 50 (2). This phenomenon can be explained both by the Abbe hypothesis and also by the Gordon interpretation, for if we examine the image of a single point its image due to the diffraction pattern given by the small aperture consists of a slit at right angles. The image of a single line, which may be considered as a row of such slits, becomes a broad band, and the grating, which now consists of a series of broad bands, will show no structure provided the width of the bands is sufficient to fill up the interspaces, This you will see is the case with the finer portion of the grating and not with the coarser. The appearance is exactly similar to the result seen in the Abbe diffraction experiment when viewed in the microscope. The next experiment is still more striking. Examining the grating as before, and placing in front of the lens a diaphragm consisting of a series of slits, placed at the correct distance, the upper half of the grating appears to be twice as fine as it really is, Fig. 50 (3). An indication, according to the Abbe theory, that having cut off the intermediate diffraction images the appearance is such as would have been caused by a finer grating, because the image is now formed by the lesser number of diffraction images. But now examine the diffraction pattern caused by our slits, first of a point, then of the line, and but little doubt can be felt that the duplication of the lines is caused by the effect of the slit diaphragm in causing a diffraction image of its own which duplicates the lines, and not by the cutting out of any diffraction spectra. It will be noticed as indicated in Fig. 50 (3) that in the lower portion where there are double the number of lines to overlap, the lines are double as brilliant, and that an extra line appears at each side of the grating. If any doubt still remains let us revolve the slit diaphragm and watch the effect on the diffraction pattern, Fig. 50 (4), first in the single line, then on the grating. As the slit revolves it will be found that the image is triplicated, and only at one position when the flanking image of one line overlaps that of its neighbour is a duplication caused as in Fig. 50 (3). This experiment, it must be remembered, is being tried with large apparatus when no question of wave lengths come into play so far as the size of object is concerned. On the table I have placed two microscopes with the Abbe apparatus, as supplied for the purpose, showing exactly the same results on a small scale. It is, therefore, evident that the experimental test of Abbe is no proof, for it is shown that the effect may be explained by the ordinary laws of diffraction of apertures quite as well as by a special diffraction forming property of the object which is being examined.

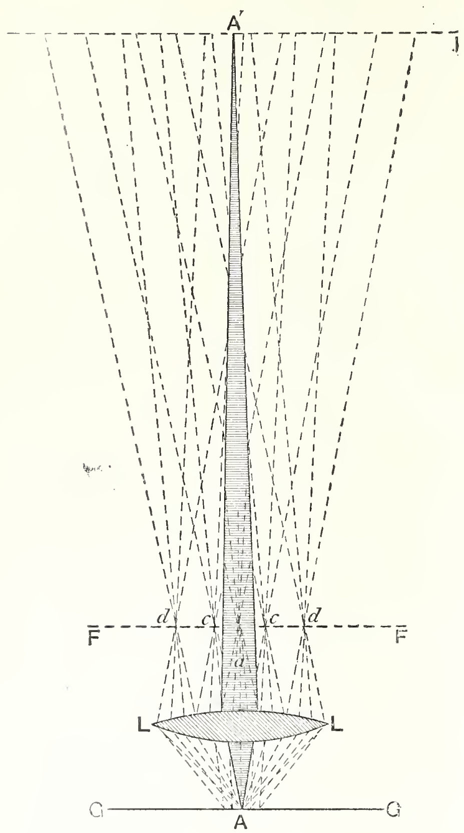
The experimental proof having been considered it will be well to return to the more theoretical aspect of the hypothesis. Suppose G G (Fig. 51) to be the grating, L L the object-glass, F the posterior principal focal plane of the object-glass, (I I) the position where the image produced by the object-glass is formed, and let A A′ represent the direct bundle of aplanatic light, (*c c*) (*d d*) represent two pairs of diffraction images caused by the interference of certain bundles of parallel rays which leave the grating in a particular phase relationship.

In the first place, these diffraction images are images, not of the grating, but of the source of light; in the next place, they only exist at this position, F F, when the light used to illuminate the object is parallel, a case which is seldom realised in practice. They will entirely disappear if the source of light, as

is usual in high-power examinations, be focussed upon the grating.

The apparatus supplied by Professor Abbe for carrying out his experiment should have the diaphragms placed at FF in the back principal focal plane of the object-glass, but, as a matter of fact, they are placed nearly three-quarters of an inch above this position, and yet work equally well. In fact, the experiment works equally well when the diffraction spectra have been made to disappear by the use of convergent illumination, or when they are formed

FIG. 51.

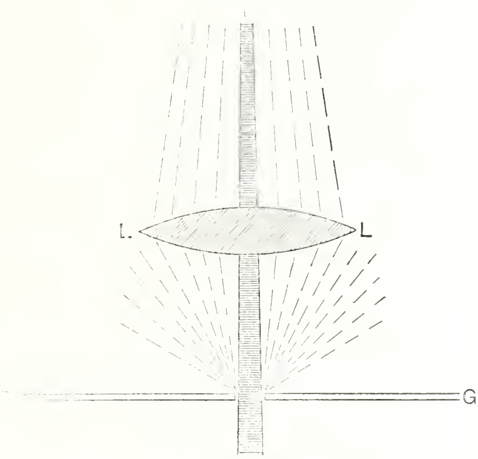


10 inches behind the object-glass instead of in its focal plane. Under these two latter conditions the slit diaphragm could not cut off any particular diffraction images, and thus the phenomenon cannot be due to the question of obscuring the light by which these images are formed. But take the case in which the diffraction images are formed at the back focal plane of the object-glass, F; can that fact have any influence on the image in the image plane, I, of the microscope? A bundle of rays that meet at C do not focus again at the image plane, even if they did, the spherical aberration of the object-glass overthrows any phase relationship, for it is well known that an object-glass that is corrected so that the planes GG and II are aplanatic will not give an aplanatic image of parallel light at the principal back focus, F. Consider the whole bundle of the rays from the point A, which pass through the object-glass, and are brought to an image at the point A′. There is one ray from each diffraction image *d d*, *c c*, which will unite at A′ and only one, and if it can be shown that these four rays were in some definite phase with reference to each other at the plane F by the time they arrive at the point A′, they will be in the same phase with each other and with the main dioptric beam due to the aplanatism of the system, for the light received at A′ is a beam with a solid wavefront with A′ as its centre, and any interference phenomenon which they may have passed through at any intermediate point is a matter of small importance. In considering this problem as applied to the case of the microscope, the conditions which actually exist in practice must be observed. A large cone of aplanatic light is being focussed to a point A′, the whole of this cone of light must arrive at the point A′ in one phase, otherwise it would not be aplanatic, and one might as well study the action of large aperture photographic lenses by reference to a pinhole photograph, as consider the effect of a minute bundle of parallel light in illustrating the action of a microscope. Thus on a physical basis it would appear that the theory does not rest on a sound foundation, and we are justified in adopting Mr. Gordon's suggestion that we should return to the consideration of the subject as if the microscope were governed by the same laws that govern other instruments. Nevertheless, the diffraction caused by the object itself has this great influence upon the subject, namely, that the sharpness of the picture is dependent on the nature of the antipoint formed by the instrument. Suppose there were a fine slit, Fig. 52, GG, on the stage of the microscope, and that there was no such thing as diffraction on the stage, that, in fact, a fine bundle of direct light only were collected by the lens. The effect would be the same as if the lens LL had a pinhole aperture, very large diffusion discs of light would be formed by the diffraction of such narrow bundles, and there would be no distinct image but for the fact that the slit GG diffracts the light so that each point sends out a complete fan and enables

the whole of the lens, L L, to be filled with light and it becomes a large aperture lens and will give small antipoints and consequently a distinct picture.

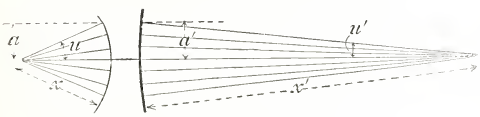
Let us then investigate the question as if the image were being formed as in the case of a telescope by converging beams of aplanatic light giving the ordinary diffraction patterns or antipoints. We saw that in order that an image of a point should appear sharp the diameter of the antipoint must be small

FIG. 52.



enough to appear as a point. It was shown that the size of this antipoint was dependent on the size of the cone of light forming the image. Fig. 53 shows a diagramatic microscope object-glass in which the lens system has been replaced by its Gauss surfaces. It will be remembered that as microscope object-glasses fulfil the sine condition those surfaces will be spherical about the conjugate foci for which they are aplanatic. Now the size of the antipoint will depend on the constant quantity,

FIG. 53.



c, dependent on the wave length and shape of the aperture divided by the sine of the angle, u', of the cone of emergent light, or

$$\frac{c}{\operatorname{Sin} u'} = r.$$

It is, however, more convenient to consider the angle of light that enters the object-glass than the angle that emerges, and the angle, u', is related to the incident angle by the relation* $\operatorname{Sin} u' = \frac{n \operatorname{Sin} u}{M}$ where M is the magnifying power and n the refractive index of the first or incident medium, and if we write the equation in the form

$$r = c \frac{M}{n \operatorname{Sin} u} = c \frac{M}{N \cdot A}$$

it is a more convenient form from which to determine the size of the antipoint. From this it will be seen that as the magnifying power, M, increases, the size of the antipoint increases, unless either the refractive index, n, or the angle of aperture, u, is also increased. The expression, $n \operatorname{Sin} u$, is the quantity known to microscopists as numerical apertures, N . A, and is in reality, when the magnifying power is taken into account, a correct measure of the semi-diameter [a' Fig. 53, divided by x'] of the cone actually forming the image.

The result may be illustrated in a more simple manner. Suppose that Fig. 43 (1) represents a low power lens forming an image of a point, it is doing so by means of a beam of incident light of a certain angle which emerges in a cone of such a size that the antipoint or diffraction disc is small, as represented by the circular spot. Suppose now that the lens is increased in power and gives an image of greater magnification, the object must be placed nearer the lens, and if the incident bundle of light is the same, the emergent cone will be less, and a larger antipoint is formed. Fig. 43 (3) shows a more extreme case, consequently with a low magnifying power, as shown in Fig. 43 (1), the antipoint might be so small as not to injure the sharpness of the picture, but with increased magnifying power the antipoint will be so large that all definition will be destroyed. Therefore, the higher the power the greater must be the angle of light allowed to enter the object-glass from each point of the object. The so-called aperture of the object-glass must be increased at each increase of magnifying power, or no advantage will be gained. The image will, it is true, be larger, but it will also be more indistinct. It is for this reason that so much stress is always laid upon the aperture of a microscope object-glass. Low power lenses have small apertures, as there is no advantage gained in giving

* The relation is as follows :—

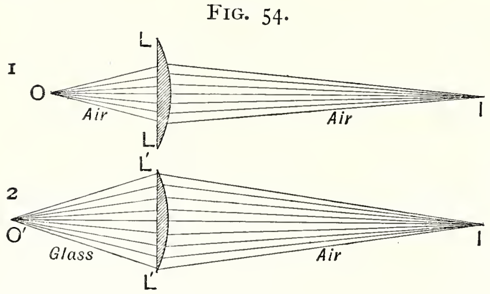
$$\frac{x}{x'} = \frac{n}{M} \qquad x = \frac{a}{\operatorname{Sin} u}$$

$$a = a' \qquad x' = \frac{a'}{\operatorname{Sin} u'}$$

$$\frac{1}{M} = \frac{\operatorname{Sin} u'}{n \operatorname{Sin} u}$$

greater aperture than the case demands, and to each magnifying power is a certain aperture that is sufficient. In the formula $r = \frac{C}{\sin u}$, for diffraction it will be noticed that the size of the antipoint depends on the constant C, which depends on the wave length of light by which the image is formed, and not by the wave length of light which emerges from the object. How is it then that placing cedar-wood oil between the object and the front of the object-glass, and thus reducing the wave length of the incident light, and not that of the light which forms the image, affects the question? It can be explained as follows:—Elementary optics prove that if, as in Fig. 54 (1) an object is placed at O in air at a distance O L, and that if, as in Fig. 54 (2) it be placed at O′ in solid glass at a greater distance in which O′ L′ is greater than the distance O L

Fig. 54.



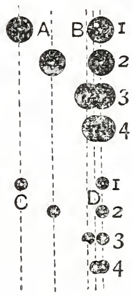
in the ratio of the refractive index of the glass to the air, the magnification of the image at I will be the same in both cases; but the diagram will illustrate, supposing that the angle of the incident rays from O and O′ is in both cases the same, the cone of emergent rays in Fig. 1 is narrow, giving a large anti-point, whilst the cone of emergent rays in Fig. 2 is large, giving a smaller antipoint. Thus, placing the object in a highly refracting medium, such as cedarwood oil, reduces the size of the antipoint, and gives greater resolving power. It must here be also remembered that light of different colours has different wave lengths, and that as the size of the diffraction antipoint depends upon the wave length, better resolution might be expected with the short wave length, green and blue light, than with red or orange, and this is amply proved by experiment. The use of monochromatic green, blue, or ultra violet for illumination, is a well recognised advantage.

The ordinary diffraction theory and the Abbe theory both lead to the same result, namely, that a certain magnifying power must be accompanied by the power of collecting rays of light of a certain angle, and it so happens that the correct ratio between magnifying power and aperture under ordinary circumstances works out at the same figure in both cases. It is generally considered that for every 100 magnifying power the numerical aperture should not be less then about ·2 N.A. The largest numerical aperture that can be readily obtained with an immersion fluid, is 1·5, and thus after a power of 750 has been reached no finer detail can be resolved. Some observers prefer to examine a small image brilliantly defined, others prefer a less distinct but larger picture, so that no hard and fast rule can be laid down. It may often be convenient and even advisable to use greater power, so as to perceive the picture with less strain, but it has been stated that at that power all that can ever be seen will be seen, and that, although it is possible to obtain a magnifying power of 10 times this amount, no advantage is gained except that a large, indistinct picture can be obtained where previously a small and brilliant image of the same detail was visible. It may be wondered why so much attention is bestowed upon the question of whether one or the other of two rival theories is the correct one. If they both lead to the same result, it can purely be a matter of academic interest. Professor Abbe's researches and achievements have been so extensive and varied that the correctness or otherwise of one piece of work would have no influence on his scientific reputation. That is true, there would be no importance in so fully discussing this matter if both theories did lead to the same result. Upon the surface they would appear to do so. Both theories point to diffraction as the determining factor in high-power image formation. Abbe's theory considers the diffraction at the object; Gordon looks only at the diffraction due to the form of the bundle of rays forming the image; but there are two important cases in which they do not. According to the Abbe theory, if an object-glass will not admit light at a sufficient angle to form interference images given off by a particular object under examination by parallel light, that object can never be seen, and an absolute limit to the resolving power of the microscope is reached. You may try every expedient that can be suggested, and no advantage will be gained after the shortest available wave length light has been obtained. Mr. Gordon has, however, pointed out new directions in which experiments

to improve high-power vision may be pursued. Starting on the assumption that the ordinary laws of diffraction may be accepted, he has attacked the problem on new lines. He has pointed out that the diffraction disc or antipoint is influenced mainly as we have seen by the size of the aperture of the object-glass, but is capable of modification by other means, notably by the shape of the aperture, and that for this reason there may be further methods of developing the power of the instrument. I think he would agree with me that at present, although the experiments look hopeful, more time is required to decide whether any marked improvement will be made. The other question is a most important practical point that is profoundly influenced by the correctness or otherwise of the Abbe theory, and that is the best method of high-power microscopic illumination. If the Abbe theory were correct and the quality of the image depended upon the brilliancy and perfection of the diffraction images given off by the object, then the best method of illumination would be to throw upon the object just that light which would produce the best diffraction images, namely, a bundle of monochromatic parallel light, whereas if Mr. J. W. Gordon's theory is correct, a wide-angled cone of aplanatic light should be used, focussed upon the stage, a cone, in fact, that would destroy all regular diffraction at the object. Practical experience has amply demonstrated the superiority of the wide angle cone of illumination in preference to the illumination by parallel light.

So far we have been considering the question of resolution, the power of distinguishing detail, the power of seeing that two points close together are two and not one, and for the determination of intricate structure this is the question of importance. When, however, isolated lines or points which are not in close juxta-position are examined, the limits of microscopic vision are not governed by the same restrictions. There is no reason why the smallest imaginable point of light should not be seen, provided it be sufficiently intense to produce a light impulse upon the human eye. That is confirmed by the fact that a brilliant star which subtends an inconceivably small angle, can be seen by the unaided eye. It is upon this principle that the recent ultra-microscopic microscope of Dr. Siedentopf has been constructed. An unusually powerful beam of electric light is thrown upon substances which contain particles otherwise invisible with the highest power microscopes, and if these particles have sufficient power of reflecting light, they will be rendered visible as spots of light. No structure is of course displayed, but their motion, if it is sufficiently great, can be observed, and some idea of their relative positions can be obtained if they are widely separated. The question as to how fine a black line on a bright field can be discerned has been investigated by Lord Rayleigh, according to the law of antipoints, from the two areas of light on each side of the minute line, and he has decided that a line as narrow as 1-16th, or under some conditions 1-32nd of a wave length of light should be visible. There is no doubt that extremely fine black lines, such as the flagella of bacteria can be seen, but as there is no means of measuring such minute filaments,

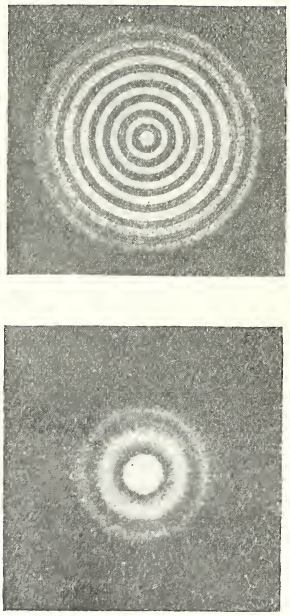
Fig. 55.



it is impossible to apply any experimental proof to the question. There can, however, be no doubt that single lines, and probably single dots of very great minuteness, are visible. Mr. Gordon has recently succeeded in producing fine points of great minuteness by a most ingenious method of using two small spherical mercury globules, one at each end of a microscope. These act as convex mirrors, and by successive reflections thrown through the instrument, from one to the other, projected images of extraordinarily small size can be obtained, and their size can be computed. Resolution, in distinction to visibility, depends upon the distance apart at which two surfaces must be situated in order that, with the highest power microscope, they can be resolved as being two, and not one element. The resolution of double stars in the telescope has been practically and theoretically investigated in a very complete manner by Airy, Rayleigh, Dawes, and many others. The first factor is the size of the two antipoints. Suppose the two antipoints were very large as Fig. 55, A and B, they might be

visible as two images in the position (1) (2) (3), but not at (4). If they were smaller as at C D they might also be visible as two separate points up to the position 4, thus the two antipoints must be as small as possible, and the question then arises as to how far these antipoints may overlap and still show as a double object. The fact that an antipoint is brighter at its centre than at its edge, makes it evident that they may overlap to some extent, and experience seems to show that if they overlap until the edge of one touches the centre of the other, they are still just visible as two images. Lord Rayleigh has pointed out that the phase relations of the two adjacent antipoints has a further influence on the question, and that if

Fig. 56.



there is a difference in phase between the two antipoints of $\frac{\lambda}{2}$ a black interference line will always be formed between them, and they might be visible as separated points when even closer. However, one may probably assume that with ordinary illumination the limit of resolution is reached when the distance between two objects is about half the antipoint. Mr. Gordon has then suggested a means of reducing the size of the antipoint by manipulating the shape of the aperture of the microscope, or, to put it more correctly, of the shape of the beam of light which forms the image, whether produced by a limiting aperture or by other means.

Figs. 47 and 48 showed the shape of the antipoint produced by beams of light having different cross sections, many of which were curious and interesting. The differences in appearance are more marked at first sight in the interference rings than in the central disc, and, if as we may probably assume, the surrounding rings are so much less brilliant as not to be visible under ordinary conditions of observation, the difference in the central disc may not appear to be very marked. Nevertheless, the central spot caused by a square aperture is square, by a slit aperture a slit at right angles to it, but the most hopeful suggestion yet put forward to increase resolution has been the use of a hollow cone of light. Fig. 56 shows in the lower diagram the antipoint of a solid cone, and in the upper diagram of the same cone with the central portion stopped out. Comparison of the figures will show that the central disc of the antipoint produced by a beam of light, of which the cross section is an annular ring, is considerably smaller than that produced by a solid cone of light. At the same time, in this case, the brilliancy of the rings is increased. The figure is a photograph from Sir John Herschel's article on light written in 1827. He points out that if the experiment is carried too far the rings becomes sufficiently intense and close together to give almost the effect of a large disc of light, and resolution is entirely destroyed. Mr. Gordon has tried the experiment of using this form of beam without carrying it to extremes, nd the interesting result is demonstrated by the two photographs, which by his courtesy I am able to show to-night. Fig. 57 is a very highly magnified image of a group of minute micrococci photographed with a solid cone of light. Fig. 58 is the same group photographed with a hollow cone and I think you will agree with me that the difference between the two photographs is remarkable. In dealing with such minute objects it is premature to assume from one experiment that the difference in appearance is the resolution of the actual structure of the object. It may quite well be an optical effect that does not bear a direct relation to the object itself, but at any rate it looks a hopeful sign of obtaining increased power.

The method by which this effect was obtained is interesting. It would obviously not do merely to illuminate the object with a hollow cone or cylinder of light, because as soon as that cone reached the object the light would be split up by reflection, refraction, and dif-

fraction in all directions, and the light received from any portion of the object would no longer be in the form of a hollow cone. It is necessary to place some obstacle between the object and the eye that will produce the required effect. In addition to this it is necessary to place this diaphragm in some place

FIG. 57.

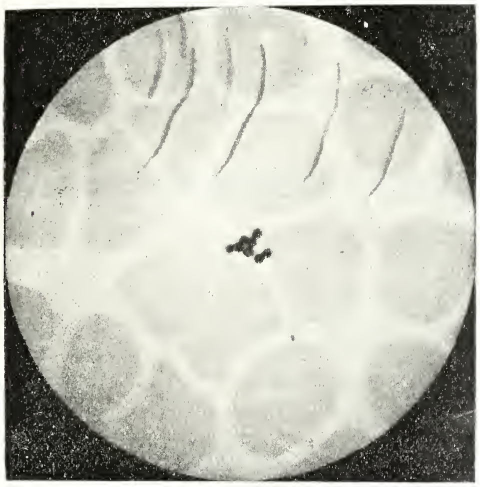
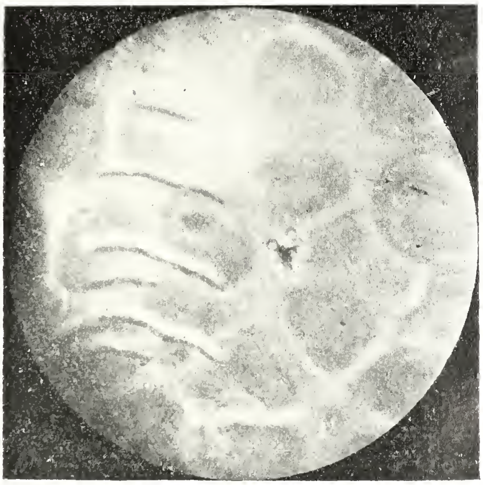
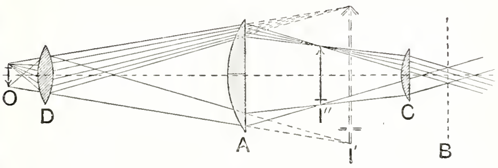


FIG. 58.



where it will affect all the bundles of light in a similar manner, otherwise only one point of the object is influenced. Now, if we consider the path of the rays through a compound microscope, it will be observed (Fig. 59) that there is only one available place, at B, where all the bundles of light cross, and can thus all be dealt with in a similar manner, and that is the so-called Ramsden circle, just above the eye-piece. Mr. Gordon has devised an adjustable holder which can be accurately adjusted so that a small sphere can be placed in the centre of the Ramsden circle, and by this means every bundle of rays coming from the object has its centre stopped out, and is rendered a hollow cylinder. The spheres are formed of mercury globules cemented between two cover glasses, and a number of different sizes are made by which the width of the sheaths of light may be varied. It would appear from the diagram that the back of the object-glass, D, would also form a suitable position at which to place an obstacle or dia-

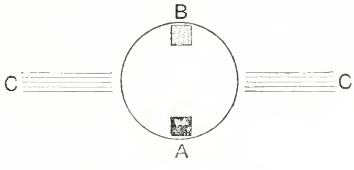
FIG. 59.



phragm, but if the light be traced through an actual object-glass, which consists of a series of lenses, it will be found that the back lens of the object-glass is not a position where the different bundles of light pass through the same area.

Another interesting case dependent on the size of the antipoint arises in connection with the resolution of fine gratings of parallel lines, such as Grayson's rulings. The finest of these rulings measure 120,000 to the inch, and by ordinary illumination are not capable of being resolved with an object-glass with a lower aperture than about 1·2 N.A., but the author showed these resolved at the Royal Society with a lens having an aperture of only 1· N.A. The explanation was that the lines were illuminated by a fine beam of wide angle light. Fig. 60

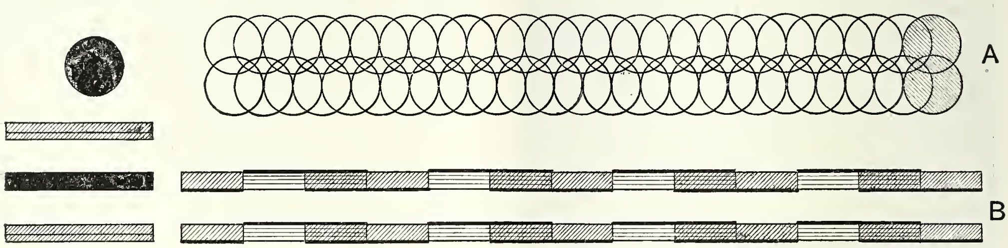
FIG. 60.



represents the back of the object-glass illustrating the illumination, the fine beam of illuminating light passed out from the object-glass at one margin at A, and the ruled grating which was placed at C C at right angles to the direction of the oblique light gave off a brilliant diffracted beam of light which passed out of the object-glass on the opposite slide at B. The image in the eyepiece was formed,

therefore, by two small beams of light. If the diagram of the antipoint formed by such beams of light be referred to, it will be seen that it is a fine line, with another line on each side parallel to the direction of the grating, and this shows why resolution was possible. Fig. 61 (A) shows a row of circular antipoints formed by a circular aperture. Fig. 62 (B) shows a row of line antipoints formed by a double beam of light of the nature employed. Thus the line structure in B is resolved by the line antipoints because these are reduced in size in the direction at right angles to the line, although they are longer in the direction parallel to the lines. This is an example of an improvement in resolution brought about by a change in the method of illumination; such a plan is useful when the character of the structure of the object is known, and the same procedure is the best method of showing the cross lines in the diatom amphipleura pellucida, there is every probability that lines 150,000 to the inch, or even finer can be shown by this method, with higher angle lenses, but as a means of examining irregular structure it is obviously not an advantage that every point should be represented by a fine line, and the most hopeful method to employ would appear to be Mr. Gordon's device of a hollow cone, which produces a smaller, though less brilliant central disc in the antipoint.

Fig. 61.



This subject introduces a further practical question. A faint illumination should be better than a brilliant glare, as by this means the antipoint disc, which is brightest in the centre and shades away in intensity towards its margin, appears smaller. To some extent this is confirmed by the best observers who work in a darkened room with moderate illumination. The discussion of the resolution of the microscope is incomplete unless some reference is made to the part played by the eye. The image formed on the retina suffers to some extent due to the false discs or antipoints, but under the ordinary conditions of vision the beams of light which form the image are comparatively large. It is, however, a curious fact that the theoretical size of the antipoints on the retina would point to about the same limit of resolution that is found actually to exist, and it is to be remembered that birds who have small eyes and comparatively large pupils have unusually great powers of distant sight. The question as to whether the limit of vision is an optical or a physiological limit is deserving of notice. If the radius* of the first dark ring of the antipoint be taken as the limit of resolution, and if we assume that the pupil of the human eye is 3 millimetres diameter, and that the wave length is $\frac{22}{1000000}$ of an inch, this limit works out as ·000141 inch, which represents an incident angle of 48 seconds. Observation gives from 30 seconds to 1 minute when tried by experiment, and the cones of the human eye are said to be placed at the most sensitive part at a distance apart of about 30 seconds. All these three values correspond.

But vision through a microscope is not vision under ordinary conditions, and this can be seen on examining the rays which emerge from a microscope. Fig. 62 shows a series of microscopes with the bundle of rays emerging from the central point of the object indicated, and whereas the light in diagrams 1 and 2 may completely fill the pupil of the eye as experienced in ordinary vision. The light in 3 is passing out of the microscope in very fine bundles, and the image on the retina is being formed by very fine cones of rays which

NOTE.—The radius of the first dark ring (r) is obtained as follows:—Take $\lambda = \frac{22}{1000000}$ inch, then λ in vitreous humour [$\mu = 1{\cdot}33$] = say $\frac{17}{1000000}$. Back focus of eye $f = {\cdot}819$ inch, aperture (a) = ·12, c for circular aperture = 1·22.

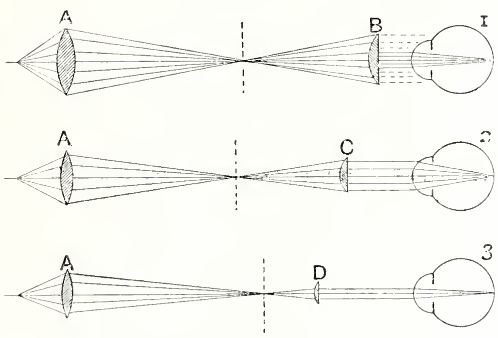
$$r = \frac{c\lambda f}{a} = \frac{1{\cdot}22 \times {\cdot}000017 \times {\cdot}819}{{\cdot}12} = {\cdot}000141.$$

N = distance of back nodal plane to retina = ·61

$$\text{Angle subtended} = \frac{r}{\text{N}} = \frac{{\cdot}000141}{{\cdot}61} = 48 \text{ seconds.}$$

do not fill the pupil, and give rise to considerable diffraction. The size of the bundles of rays, which emerge from the eyepiece, is best investigated by measuring the size of the Ramsden circle or eyepoint, which was de-

FIG. 62.



scribed in Lecture I. as being the disc outside the eyepiece, through which all bundles of rays passed. This diameter of the Ramsden circle supplies a good deal of useful information about the microscope.

Its radius is equal to the numerical aperture of the object-glass, multiplied by 10 and divided by the total magnifying power of the instrument, and the diameter is therefore $D = \frac{20\,n \text{ Sin } u}{M}$ or $20\,\frac{(\text{N. A.})}{M}$. This formula is useful, because it makes the calculation of the diameter of the Ramsden circle very simple. It merely depends on the magnifying power of the microscope and the numerical aperture.

For a magnifying power of 100, and a numerical aperture of ·1, the formula becomes :—

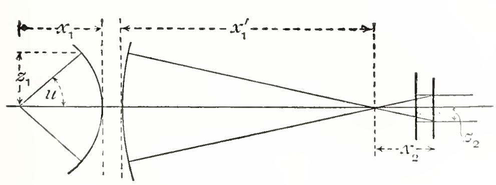
$$
\begin{aligned}
\text{D.} &= \frac{20 \times \cdot 1}{100} &&= \cdot 02 = 1\text{-}50\text{th}'' \\
\text{N. A.} &= \cdot 2 \ \text{D} &&= \cdot 04 = 1\text{-}25\text{th.} \\
\text{N. A.} &= \cdot 3 \ \text{D} &&= \cdot 06 = 1\text{-}16\cdot 6\text{th.} \\
\text{N. A.} &= \cdot 4 \ \text{D} &&= \cdot 08 = 1\text{-}12\text{th.} \\
\text{N. A.} &= \cdot 5 \ \text{D} &&= \cdot 1 \ \ = 1\text{-}10\text{th.} \\
\text{N. A.} &= \cdot 6 \ \text{D} &&= \cdot 12 = 1\text{-}8\text{th.}
\end{aligned}
$$

Some authorities have pointed out that the measurement of aperture may be made by experimentally ascertaining the diameter of the Ramsden circle, but such a plan is undesirable, because it is difficult to measure so small a diameter with accuracy. The results are also misleading, unless care is taken to see that the whole angle of the object-glass is utilised. If a small pencil of light be thrown through a wide angle lens, the size of the Ramsden circle will appear to be much smaller than if the full angle of the object-glass had been illuminated, and the size of the Ramsden circle is of more value when it is desired to describe the angle of illumination used, and not the total angle of an object-glass.

The above formula becomes more interesting when applied to higher magnifying powers. For suppose the total magnifying power of a microscope to be 100, the sizes of the Ramsden circle are :—

N. A.	·5 =	·01 =	1-100th inch.
N. A.	1· =	·02 =	1-50th ,,
N. A.	1·5 =	·03 =	1-33rd ,,

NOTE.—The formula for diameter of the Ramsden circle is obtained as follows. It is a conjugate image made by the eyepiece of the equivalent or principal plane of the object-glass. (*See* Lecture I.)



$$-\frac{z_1}{x_1} = \text{Sin } u \qquad n\,\frac{x'_1}{x_1} = m_1 \qquad x_1 = \frac{x'_1\,n}{m_1}$$

$$\therefore\ z_1 = -\frac{n \text{ Sin } u\ x'_1}{m_1}$$

$$z_2 = \frac{x_2}{x'_1}\,z_1$$

$$z_2 = -\frac{x_2\,n \text{ Sin } u}{m_1}$$

If the light emerges from the eyepiece in parallel beams, $x_2 = -\ \phi_2$, and

$$\phi_2 = \frac{10 \text{ inches}}{m_2}, \text{ and } m_1 m_2 = \text{total mag. power M.}$$

$$\therefore\ z^2 = \frac{10\,n \text{ Sin } u}{M} = \frac{10}{M}.\ \text{N.A.}$$

z_1 = radius of aperture of object-glass on nodal planes.
z_2 = radius of Ramsden circle.
x_1 = distance of object from object-glass.
x'_1 = distance of first image from object-glass.
n = refractive index to left of object-glass, the refractive index to right being considered 1 (air).
m_1 = magnification of first image.
n_2 = distance of first image from eyepiece.
m_2 = magnification ef eyepiece.
ϕ_2 = focal length of eyepiece.

The distance of the Ramsden circle from the second equivalent plane of the eyepiece is obtained as follows :—

$$\frac{1}{x'} - \frac{1}{x} = \frac{1}{\phi_2}$$

$$x' = \frac{\phi_2\,x}{x - \phi_2}$$

x = distance of second equivalent plan cf the object-glass to first equivalent plane of the eyepiece.
x' = distance of Ramsden circle from second equivalent plane of eyepiece.

In all three cases, the pencils of light emerging from the eyepiece are very small, and may be expected to give rise to diffraction in the eye of an injurious nature.

The limit of resolving power of the eye, with a pupil aperture of 1-50th of an inch, is reduced to an angle of about five minutes. Nevertheless this is as great as that of the microscope so arranged that the Ramsden circle is of that diameter.

It can easily be shown that the size of the antipoint will depend on the diameter of the beam of light forming the image, and provided the eye does not further reduce this beam of light, there will be no further loss of resolution due to diffraction in the eye. Where, however, the eye deteriorates, the image is where the pupil reduces the beam and does not admit the whole of the light. In that case, as shown in Fig. 62 (1), the portion of the light indicated by dotted lines is not admitted to the eye, and the object-glass might just as well have had a smaller aperture. This illustrates the fact that when magnifying power is low it is quite possible to overdo the aperture of the object-glass.

This closes the purely theoretical aspect of our discussion, and the fourth lecture will deal with certain practical applications of the theory. But at the close of this address I will add a personal note of scepticism which I think arises in the mind of every optician whose life is spent in the consideration of the aberrations of lenses. The whole of the beautiful theory of diffraction, as applied to instruments, presupposes that the images formed by them are so perfect that the phase relationship of the light is retained throughout, or, if not in its entirety, at least to such an extent that the results of the diffraction theory may be consistently applied. Experiment tends to show that the diffraction results do actually occur as predicted by theory to some extent at least, but I find it difficult to believe that the image of a point formed by an optical instrument is ever sufficiently perfect to enable the laws of diffraction to be applied without modification.

The aberrations of a lens may be so perfect that the image of a point is apparently very small, but such an image can always be seen by sufficiently rigorous observation to be far from perfect when such minute quantities as wave lengths of light are taken as the standard of measurement.

The light forming such an image should theoretically consist of two cones of light with their points in contact; in practice it is more like two champagne bottles with their corks in contact, and the exact positions where the light from different portions of the lens focusses are separated by much greater distances than the length of one or two wave lengths of light. If this is so, the resultant diffraction pattern must be more abstruse in its nature than theory would predict. It is indeed surprising that any regular diffraction takes place at all, and it would be unwise to accept any final limit for the resolution of the microscope that is not confirmed by experiment.

THE INDIAN POST-OFFICE.

The annual report on the Post-office in India for the year 1906-07, shows that the statistics are far below those of a highly civilised country like our own, in spite of the enormous population of the former. For instance, the number of letters, postcards, newspapers, packets and parcels issued for delivery, was over 779 millions in the case of India, and over 4,862 millions in the case of the United Kingdom, during the year 1906-07. On the other hand, the general percentage of increase was far larger in India, being 3·8 for the United Kingdom, and 6·21 in the former. With regard to letters and postcards only, the Indian increase was over 38½ millions. One of the special features of the Indian Post-office is the success attending the institution of the value-payable post, where the Department collected for sailors a sum aggregating 6½ crores of rupees, realising as commission a sum of over £60,000 sterling. In regard to the Post-office Savings Banks, there were 1,190,220 active accounts in existence at the end of the year, showing a net increase of 6·67 per cent., 94½ per cent. of all the accounts being those of private persons. The amount deposited increased by over 38½ lakhs of rupees. There is another point in which the Indian postal business exhibits a striking contrast to the English system, and that is that there were 24 highway robberies of the mail in the former case. Three of these were attended with loss of life. In another instance the mails contained no cash, but they contained a copy of Sir W. Moore's "Manual of Family Medicine and Hygiene," which the robbers were considerate enough to return to the Political Agent for Zhob. Among the casualties befalling postmen and runners are recorded a few deaths by drowning, one death by a tiger, and several by avalanches on the mountains. The total number of the officials of the Post-office, on the 31st March last, was 85,873, only 75 of whom were women. On the other hand, we may mention by way of contrast that the total number of persons on the strength of the British Post-office at home (established and unestablished) was 199,178, of whom 41,982 were women.

HOME INDUSTRIES.

The Coal Trade.—For coal owners 1907 was among the most prosperous of years. Throughout the year, with very brief intermissions, shipments from the Tyne and Blyth were on an unprecedented scale. It is estimated that those from the Tyne will work out at over 18,000,000 tons. The demand for steam coal throughout the year has been very active, and the same is to be said of the house coal trade. In a year of general and great prosperity the Welsh coal trade has been particularly prosperous. Prices were very satisfactory, and many of the large contracts were placed at advances of 25 per cent. to 30 per cent. on the figures secured for similar contracts in 1906. The year opened with a great foreign demand for South Wales coals. Many collieries had actually to refuse orders, and there was great congestion owing to the sudden demand and the inadequate loading facilities at Cardiff and other South Wales docks. Exports were enormous, and the price of Welsh coal was abnormally high, and the increase in foreign exports for the year amounted to considerably over 2,000,000 tons. New colliery works are being developed in several centres, and the Rhymney Iron Company's pair of steam pits at Deri are expected to rank amongst the largest in Monmouthshire and South Wales. As a rule when prices on the open coal market have ruled high contract prices have been comparatively low, and *vice-versâ*, but 1907 was an exception. Contract figures represented advances of from 4s. to 5s. per ton on the previous year's prices. The profits earned by colliery owners were immense. To take a few representative collieries:—

Colliery.	Profit.		
	1905.	1906.	1907.
	£	£	£
Baldwin's, Ltd. ..	43·028	81·302	120·192
Ebbw Vale	55·793	59·872	140·533
Newport, Abercarn	22·253	24·853	36·183
Tredegar	66·613	80·958	121·956

A notable feature of the market has been the demand for small steam coals. Not so very long ago looked upon almost as a negligible quantity, they are now a valuable commodity, largely owing to the fact that the furnaces of modern steamers are so improved that they will burn practically any class of "small." If 1907 was a year of very exceptional prosperity for coal owners, in a lesser degree it was a good time for the miners. It was not until the year was wel advanced that the miners received the full benefit of the prosperous condition of the trade, while for the whole year almost without cessation colliery owners reaped the benefit of the demand for coal and enhanced prices. But the miners were great gainers, too. At the beginning of the year their wages stood at $37\frac{1}{2}$ per cent. above the standard of 1879. In March there was an increase of $3\frac{3}{4}$ per cent., in June of $11\frac{1}{4}$ per cent., in September of 5 per cent., and in December of $2\frac{1}{2}$ per cent. In December, for the first time since the establishment of the Arbitration Board, wages of miners in the South Wales coalfield reached the maximum of 60 per cent. above the standard rate of 1879. The new year opens with coal averaging from 2s. 6d to 3s. per ton more than it did at the beginning of 1907. A somewhat lower range of wages may be looked for now that the abnormal export demand has ceased.

Shipbuilding and Docks.—There was a considerable falling off in the total output of tonnage from the shipping yards of the United Kingdom in 1907 as compared with the record year of 1906, the figures being for 1906 1,874,797 tons, as against 1,668,429 tons last year; but, though the decrease is large, it is less than was generally anticipated some months ago. And in the Clyde there was a record output, the figures for 1907 being 577,546 tons, against 575,433 tons in 1906. Many of the vessels and craft built on the Clyde consisted of special classes built for foreign and colonial orders. The greatest volume of tonnage launched by any one firm in the year was by Messrs. W. Doxford and Sons' output at Sunderland, where they turned out 91,254 tons, as compared with Harland and Wolff's output of 72,412 tons, Russell and Co.'s of 71,705 tons, aud that of Swan, Hunter and Wighan Richardson of 69,063 tons. The past year has seen a considerable extension of dock accommodation, notably at Cardiff, where the King opened the Alexandra Dock, and also at Swansea and Newport, where accommodation is being provided adequate for handling even the *Mauretania*. At Liverpool there has been improvement in depth of water and space; on the Clyde the blowing up of the Elderslie Rock has increased the depth of water to 28 feet at low tide; on the Tees a fine system of docks, embracing repairing facilities, is being built; shipbuilding has been revived on the Mersey, and new yards established and existing ones extended on the Clyde. The outlook for shipbuilding has not been encouraging of late, but with characteristic enterprise the shipbuilders are determined to keep in advance so that they may be able to meet all the requirements certain to be made of them when the price of shipbuilding materials is lower and freights are less discouraging.

The Wages of Seamen.—It is satisfactory to find that the seamen and firemen have participated in some small degree in the advance of wages enjoyed by the workmen in so many trades. Tables compiled by the Board of Trade show that there has been improvement, although it is very small. The aver-

age monthly rate of wages with food for able seamen in 1906 was 80s. 7d., and of firemen and trimmers 85s. 4d., being an improvement in the one case of 2d. and in the other of 3d. on the rates of the preceding year. The average wages of seamen in sailing vessels was 60s. 3d., an improvement of 1d. The money gain is insignificant, but the Shipping Act of 1906 has improved the victualling scale and other conditions of seafaring life. The total of seamen employed in 1906 was 201,408, as against 186,636 in 1901, showing an increase during the quinquennium of 14,732. The increase is mostly accounted for by engineers, firemen, stewards, and shipworkers. The skilled seaman, like the sailing vessel, will soon be of the past only. It is satisfactory to note that the number of British seamen in the mercantile marine increased during the quinquennium from 120,412 to 128,077. There was a slight increase in the foreign element, from 32,614 to 34,906, and the Lascars increased from 33,610 to 38,425. If British seamen are to be attracted in adequate numbers, that is to say, if the foreigner is to be dispensed with, shipowners will have to go further in the direction of making the seaman's life on board ship comfortable. Something —a good deal—has been done in recent years with this object, but more remains to be done if the right sort of men are to be attracted to, and retained in the mercantile marine.

The Drapery Centre.—The *Manchester Guardian* directs attention to the removal of the oldest of Bradford home-trade houses to London as marking another stage in Bradford's decline as a wholesale drapery centre. Drapery buyers do not visit Bradford in large numbers, but they do visit London, which explains the transference. The company in question are to carry on their shipping department in Bradford, and to deal with their cottons there. As a centre for shipping merchants Bradford apparently gains rather than loses in importance, although some of the numerical growth of separate businesses is due to the fission of old firms. Home traders are considering whether Manchester is not a more eligible centre even than London, and there are merchants of long experience in the Bradford trade who think it is. Something depends upon the class of work sought. For merchanting dress goods for the Midlands Manchester is considered preferable. It is nearer to the denser masses of population, and to the mills, rents are lower, so are general expenses, and the growth of drapers visits to Manchester is a main factor. Anyway, many Bradford home traders are said to have their eyes on Manchester. Removal thither seems to them a less speculative measure than migration to London.

The Cotton Crop.—American cotton crop estimates continue to differ widely, but the balance of evidence warrants the opinion that the yield will not be less than 12,000,000 bales. Anyway, American spinners are not alarmed, but trade is not what it was. A year ago the mills were sold far ahead, but now business has fallen off so much that some curtailment of production seems certain. With a crop of, say, 12,000,000 bales, and the shrunken production that must be expected as a consequence of the American financial collapse, American exports of raw cotton are not likely to fall short of an average. It is the cotton crop shortage elsewhere that is the disturbing factor in the situation. Admittedly the Indian yield will be smaller, and the same may be said of Egypt, Russia, Mexico, and South America. Some estimates put the world's shortage at 4,000,000 bales, which may be safely described as a great exaggeration, and the visible and invisible supplies carried over from last year were very large.

The Tin-plate Trade.—Next to the coal trade the Welsh tin-plate trade was probably the most prosperous of all Home Industries in 1907. It was a record year for this trade. In the eleven months ended November 30th the exports of tin and black plates were 438,817 tons as against 404,610 tons in the corresponding period of 1906. 1891 was known as the "boom" year of the trade, yet in that year the exports were only 448,579 tons, or 9,562 tons more than in the first eleven months of 1907. The figures for the home consumption are even more remarkable. In 1891 they were 75,000 tons, last year 213,000 tons. In 1907 there were more mills in operation then in any preceding period, and the production per mill was greater than ever before. The men are paid on task and have, consequently, earned more than ever before. On the other hand, in America, notwithstanding the tariff, only 20 per cent. of the tin-plate mills are at work. A few weeks ago the United States Steel Corporation threatened that unless the Welsh tinplate makers bought a stipulated quantity of the Corporation's bars they would be smashed; the Corporation would turn its bars into tin-plates and compete with the Welsh makers in every market in which they did business. The Welsh makers treated the proposal as mere bluff and rejected it without hesitation. Concurrently with this attempt at American dictation, a movement has begun amongst the tin-plate makers for direct association with and participation in the profits of works manufacturing steel bars. Whenever works have been large enough to warrant the laying down of steel bar mills in conjunction with tin-plate mills, the association has been found very profitable. In the early part of the year, the men sought an advance of 10 per cent., but finally accepted an agreement that the wage rate shall remain stationary both for good and bad times, and that an eight-hours' shift shall be established. Probably the prosperity of the trade in 1908 will be a little short of that of 1907, but the makers anticipate a continuance of brisk trade.

CORRESPONDENCE.

ENGLISH HOPS.

May I be allowed to make a few comments on an article, entitled "The Hop Position," which appears in the issue of the Society's *Journal* for Dec. 27. It is possible, as the writer states, that "if foreign imports were practically excluded by duty, this exclusion would probably lead to an extension of the acreage under hops, that would soon reduce prices to the old level," but it would also mean the continued cultivation of a very much larger acreage than at present, and a much greater amount would have to be spent in wages for cultivating and picking the hops grown. These wages would be paid to our own people, and not indirectly to foreigners, as at present, by the purchasers of foreign hops. This would benefit the general community, by reducing the number of the unemployed, and it is certainly better for all concerned to provide work than to have to support the unemployed, by means of special rates and charity. I may add that I do not regard this question from a political point of view, but merely from one of common sense. JAMES H. BUCK.

56, Birdhurst-road, South Croydon.
December 30th, 1907.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 15.—"Screen-Plate Processes of Colour Photography." By C. E. KENNETH MEES, D.Sc., F.C.S.

JANUARY 22.—"Siam and its People." By HARRY HILLMAN.

JANUARY 29.—"The New Patent Act." By JOHN WILLIAM GORDON. SIR WILLIAM PREECE, K.C.B., F.R.S., Vice-President of the Society, will preside.

FEBRUARY 5.—"War Balloons." By AUGUSTE E. GAUDRON. The HON. CHARLES ROLLS will preside.

FEBRUARY 12.—"The Application of Science to Foundry Work." By R. BUCHANAN, President Staffordshire Iron and Steel Institute.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

JANUARY 16.—"Indian Agriculture." By HENRY STAVELEY LAWRENCE, I.C.S., Director of Agriculture, Bombay. SIR JAMES MONTEATH, K.C.S.I., late Member of Council and Acting-Governor of Bombay, will preside.

FEBRUARY 13.—"The New 'Imperial Gazetteer of India.'" By RICHARD BURN, I.C.S. (To be read by WILLIAM FOSTER.)

MARCH 12.—"Progress of Native States during the past Forty Years." By SIR DAVID W. K. BARR, K.C.S.I., Vice-President of the Council of India.

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

JANUARY 28.—"The Development of Colonial Self-Government in the Nineteenth Century." By A. BERRIEDALE KEITH, M.A., B.C.L., M.R.A.S.

FEBRUARY 25.—"Irrigation in Egypt under British Direction." By SIR HANBURY BROWN, K.C.M.G.

MARCH 24.—"The Mineral Resources of Western Australia." By the HON. C. H. RASON, Agent-General for Western Australia.

APRIL 7.—"The Imperial Problem of Asiatic Immigration." By RICHARD JEBB.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

JANUARY 21.—"Developments in the Art of Jewellery." By Mrs. HADAWAY.

FEBRUARY 18.—"Banners in Pageantry." By GEORGE W. EVE. WALTER CRANE, R.W.S., will preside.

MARCH 31.—"Enamel Portraits." By CYRIL DAVENPORT, F.S.A. SIR HUBERT VON HERKOMER, C.V.O., R.A., will preside.

APRIL 28.—"Lace as a Modern Industry." By Miss ISEMONGER.

MAY 26.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

HENRY HARDINGE CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." Six Lectures.

LECTURE I.—JANUARY 20.—The history of clocks—The verge escapement—Invention of the pendulum—Its adaptation to clocks—The anchor escapement—The dead-beat escapement—Attempts at detached escapements—The gravity escapement—Remontoirs—Detached gravity escapements—Electric clocks.

LECTURE II.—JANUARY 27.—The theory of the pendulum—The simple pendulum—Motion of a particle under an accelerating force—Motions upon a curve—The cycloid—Motions in a circular arc.

LECTURE III.—FEBRUARY 3.—The simple pendulum concluded—The compound pendulum—General formula—Moment of inertia—Corrections for circular error, and for moment of inertia of bob—Air buoyancy, its effect on pendulums.

LECTURE IV.—FEBRUARY 10.—Method of compensating pendulums for the expansion of the rod, the bob, and the temperature of the air—Barometric

correction—Method of construction of pendulum—The gridiron, the mercury, the zinc and steel, lever and other pendulums.

LECTURE V.—FEBRUARY 17.—The pendulum continued—Modes of suspension—Air-tight cases—The escapement—Principle of the escapement; effect of disturbances—The dead-beat escapement—Detached escapements and gravity escapements—The escapements of Mudge, Cummings, Bloxam, and Denison.

LECTURE VI.—FEBRUARY 24.—The theory of escapements concluded—Teeth of wheels—The theory of epicycloidal teeth — Involute teeth — Lantern pinions—Electric clocks—Main divisions of electric clocks—Difficulties to be contended with—The clock of the future.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

FEBRUARY 7.—"The Hygiene of the Pottery Trade." By WILLIAM BURTON, F.C.S., Chairman of the Joint Committee of Pottery Manufacturers of Great Britain.

FEBRUARY 28.—"The Removal of Dust and Fumes in Factories." By JOHN SCOTT HALDANE, M.A., M.D., M.R.C.P. (Edin.), F.R.S.

MAY 15.—"The Dangers of Coal Dust and their Prevention." By W. E. GARFORTH, President of the Colliery Proprietors' Association of Great Britain.

HOWARD LECTURES.

Thursday evenings, at 8 o'clock :—

H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

March 19, 26, April 2.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 13...Surveyors, 12, Great George-street, S.W., 8 p.m. Professor Henry Robinson, "Foreshore Erosion and Reclamation."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Dr. T. Anderson, "Among the Volcanoes of Guatemala and St. Vincent."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. A. R. Hinks, "The Evidence for Life on Mars."

TUESDAY, JAN. 14...Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. E. H. Walsh, "The Coinage of Nepal."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. A. Gray, "The Internal Ear of Different Animals." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Sir Whately Eliot's paper, "Keyham Dockyard Extension," and on Mr. George Hall Scott's paper, "Keyham Dockyard Extension: Temporary Works, and Plant and Appliances used in Construction."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. Howard Farmer, "The Modes of Action of Ruled and Analagous Screens, and their Applications to Photo-Engraving."

Zoological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Sir Henry Blake, "Ceylon of To-Day."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m.

WEDNESDAY, JAN. 15...SOCIETY OF ARTS, John street, Adelphi, W.C., 8 p.m. Dr. C. E. Kenneth Mees, "Screen-Plate Processes of Colour Photography."

Meteorological, 25, Great George-street, W., 7½ p.m. (Annual Meeting.) Address by Dr. H. R. Mills, President, on "Map-Studies of Rainfall."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. W. Wesché, "The Microscope as an Aid to the Study of the Biology of Insects, with special Reference to the Food." 2. Mr. J. E. Barnard, "An Improved Type of Mercury Vapour Lamp, for use with the Microscope."

Entomological, 11, Chandos-street, W., 8 p.m. Annual Meeting.

Auctioneers, 34, Russell-square, W.C., 7¾ p.m. Mr. Cyril Davenport, "Mezzotints."

British Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, JAN. 16...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Henry Staveley Lawrence, "Indian Agriculture."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Mr. Arthur W. Sutton, 1. (*a*) "*Brassica* Crosses;" (*b*) "Notes on Wild Types of Tuber-bearing Solanums," 2. Mr. S. T. Dunn, "Revision of the genus *Illigera* (Blume.)" 3. Mr. Bunzo Hayata, "New Coniferæ of Formosa."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. J. J. Fox and J. T. Hewitt, "Colour and Constitution of Azo-compounds. (Part II.) The Salts of p-hydroxyazo-compounds with Mineral Acids." 2. Mr. F. D. Chattaway, "The Oxidation of Aromatic Hydrazines by Metallic Oxides, Permanganates, and Chromates" 3. Mr. A. Slator, "Studies in Fermentation. (II.) The Mechanism of Alcoholic Fermentation." 4. Messrs. H. Marsden and F. S. Kipping, "Organic Derivatives of Silicon. (Part IV.) The Sulphonation of Benzylethylpropylsilicyl Oxide and of Benzylethyldipropyleilicane." 5. Messrs. C. W. Moore and J. F. Thorpe, "The Formation and Reactions of Imino-compounds. (Part VI.) The Formation of Derivatives of Hydrindene from o-xylylenedinitrile."

London Institute, Finsbury-circus, E.C., 6 p.m. Mr. J. S. Scarf, "Flames."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. W. Watts, "The Building of Britain."

Optical, 20, Hanover-square, W., 8 p.m. Mr. H. L. Taylor, "The Relative Value of Parts in Spectacle Frame Manufacture."

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m. Mr. G. W. Forrest, The Siege of Madras, reviewed and illustrated from original documents.

Numismatic, 22, Albemarle-street, W., 6½ p.m.

FRIDAY, JAN. 17...Royal Institution, Albemarle-street, W., 9 p.m. Prof. T. E. Thorpe, "The Centenary of Davy's Discovery of the Metals of the Alkales."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Dr. Herbert Lapworth, "The Principles of Engineering Geology." (Lecture II.).

Quekett Microscopical Club, 20, Hanover-square, W., 8 p.m.

SATURDAY, JAN. 18...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gilbert Kapp, "The Electrification of Railways." (Lecture I.)

Journal of the Society of Arts.

No. 2,878. VOL. LVI.

FRIDAY, JANUARY 17, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 20, 8 p.m. (Cantor Lecture.) H. H. CUNYNGHAME, C.B., "The Theory and Practice of Clock Making. (Lecture I.)

TUESDAY, JANUARY 21, 8 p.m. (Applied Art Section.) Mrs. HADAWAY, "Developments in the Art of Jewellery."

WEDNESDAY, JANUARY 22, 8 p.m. (Ordinary Meeting.) HENRY HILLMAN, "Siam and its People."

Further details of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

Thursday Afternoon, January 16; Sir JAMES MONTEATH, K.C.S.I., in the chair.

The paper read was on "Indian Agriculture," by HENRY STAVELEY LAWRENCE, I.C.S., Director of Agriculture, Bombay.

The paper and discussion will be published in a future number of the *Journal*.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE THEORY OF THE MICROSCOPE.

By CONRAD BECK, F.R.M.S.

Lecture IV.—Delivered December 16th, 1907.

PRACTICAL APPLICATIONS OF THEORY.

Syllabus.—The best combination of eyepiece and object-glass—Illumination with high-power eyepieces—Dust with high-power eyepieces—Gordon's oscillating screen—Useful aperture—Penetration and depth of focus—Small apertures for photography—Penetration in highly refracting media—Effect of cover-glass—Correction for error thus produced—Illumination—The sub-stage condenser—Best angle of illumination—Illuminants—Mono-chromatic illumination—Sir A. Wright's experiments—Critical illumination—Transparent and opaque objects—Necessity for study of illumination.

The preceding lectures have briefly outlined the theory of the microscope. There are gaps that require to be filled, and more detailed consideration should be bestowed on many of the individual steps in order to form an adequate groundwork for the study of the microscope. Such an elaboration as would satisfy the student cannot be attempted in a few addresses, and I propose in this last lecture to apply to practical questions some of the theoretical matters which have been investigated.

These practical questions will tend in one direction, namely, towards ascertaining the best methods of obtaining the most perfect images with high powers.

There are other questions equally interesting, but nothing that is at present so important. Since the discovery that disease is frequently the direct result of minute germs, or of changes in microscopic cell structure, it has been strongly impressed upon scientific investigators that the microscope, even at its

best, is a peculiarly inadequate instrument with which to fight the battle against disease, and that every endeavour should be made to study what are the limits to microscopic vision and what methods can be devised to widen them.

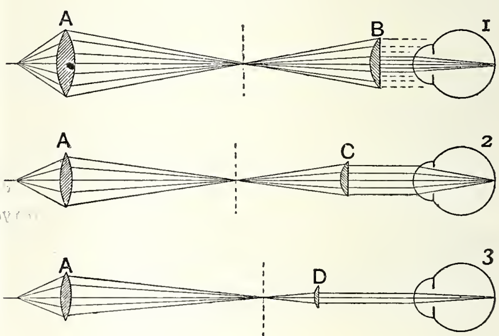
The microscope consists of two definite portions, the object-glass and the eyepiece; each of these parts is, with but slight reservations, corrected in itself, so that each different object-glass can be used with each eyepiece, and it is important to consider the most advantageous method of combining them. What is the best combination of eyepiece and object-glass that should be employed to obtain a particular magnifying power?

Having searched with a low power over a specimen, and found a spot to be examined under greater magnification, the easiest thing to do is to remove the eyepiece, and drop in a more powerful one. It does not appreciably alter the focus, there is no necessity to shift anything, and it produces the extra magnification, but such a procedure is disappointing. There are definite reasons for this. Every object-glass, however well made and designed, has some residual errors. Let us suppose that it magnifies 10 diameters and a low eyepiece magnifying 5 is in use with it, giving a combined power of 50, the errors of the object-glass are exaggerated 5 times. If a magnification of 200 is required, an eyepiece magnifying 20 gives the increased power, but all the errors of the object-glass are multiplied by 20 instead of by 5. Five times the error might not be noticeable, when 20 times would destroy the perfection of the image.

Thus, for this reason alone, when a high magnifying power is required, it is better to increase the power of the object-glass and not that of the eyepiece. There are, however, other reasons why the use of high-power eyepieces is not desirable. One of these depends upon the illumination. Beyond a certain point the use of high-power eyepieces produces a very serious loss of light. This can be explained by reference to Fig. 62 (Lecture III.), which is here repeated.

Suppose the object-glass to be represented by a lens, Fig. 62 A, and the eyepiece by a lens B, or in the lower diagrams C and D. Simple lenses will serve for illustration because, to demonstrate this point, the exact centre of the object need only be considered. The bundle of light coming from that central point is shown converging to a point in the focus of the eyepiece. From there it spreads out till it reaches the eye lens B, which causes it to emerge from the microscope as a nearly parallel bundle which passes into the pupil of the observer's eye. Let the eyepiece in the upper diagram (1) be replaced by a more powerful eyepiece as shown at C, and the emergent beam of light will be modified. The reason why C is more powerful than B is that it is shorter in focus and must be placed closer to the image formed by the object-glass, the rays, therefore, do not expand to such a large diameter before they reach the lens, and they emerge from the microscope as a much narrower beam than in the case of the low power eyepiece B. Thus the higher the power of the eyepiece the narrower are the bundles of light which enter the eye from each point

Fig. 62.



of the object. Consideration of this point explains a fact well-known to experienced microscopists. It is observed when using eyepieces of moderate power that changing the eyepiece makes little difference in the apparent brightness of the image, whereas once a certain power is overstepped any further increase rapidly reduces the illumination. This is because as long as the emergent bundles of light are larger than, or as large as the pupil of the observer's eye, the maximum light is received upon the retina, and the illumination is the same whatever the power employed. Immediately that point is passed at which the emergent bundles of rays are smaller than the pupil of the eye, the amount of light received by the retina depends not upon the size of the pupil, but upon the size of the emergent beams of light.

With most low-power object-glasses increasing the power of the eyepiece from 5 to 8 does not usually reduce the illumination, whereas a further increase to 16 will reduce the illumination to one quarter. If high-power

object-glasses are employed the falling-off in illumination commences earlier, as except with very wide angle lenses the emergent beams seldom greatly exceed the size of the pupil of the observer's eye.

Incidentally the narrow bundles of rays emitted by high-power eyepieces give rise to another defect. They show the least speck of dust on the eyepiece, or the imperfections in the fluids or lens of the eye.

If a small speck of opaque material be interposed in the path of a large bundle of light it will obliterate a fraction of the light, but such a small fraction that no noticeable effect will be produced; but if the individual bundles of light are no larger than the opaque obstruction, one entire beam of light will be blocked out and a black shadow will be seen upon the object. This accounts for the difficulty that is experienced in keeping a high-power eyepiece sufficiently clean and free from dust and for the appearance of moving shadows which is observed with high eyepieces, due to the presence of particles in the fluids of the eye.

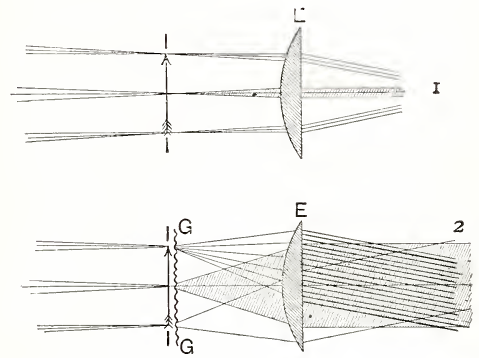
For this reason it is not advisable largely to increase the power of a microscope by means of the eyepiece. High power object-glasses made by modern methods of manufacture have optical errors scarcely larger than those of lower power, and there can be no doubt, therefore, as to how the high-power microscope should be made.

As to the question of obtaining increased power by increasing the tube length of the microscope—of separating the object-glass and eyepiece by a great interval—a little consideration will show that exactly the same considerations that render it inadvisable to gain too much power by means of eyepieces apply with equal force to this method.

Mr. J. W. Gordon has invented an extremely ingenious device by which the fine pencils of light given off under high eyepiece magnification are turned into large bundles. With his oscillating screen the black shadows due to imperfections in the eye or any portion of the instrument are rendered invisible, and this particular objection to the use of high eyepieces is removed.

Fig. 63 (1) is a diagram representing an image I formed by the object-glass which is being thrown by the eyepiece E into the observer's eye. Owing to the high power of the microscope each pencil of light received by the eye is very small. Mr. Gordon places a ground-glass screen G, Fig. 63 (2) in the plane of the image, the effect of which is to disperse the light in all directions, and turn the fine pencils of light into broad bundles. The reason that the light is dispersed is, of course, due to the rough surface of the ground glass, and under the high magnifying power of the eyepiece this rough surface appears like the pebbles on the seashore, and the fine detail of the microscopic image is entirely obliterated. If, however, the screen is kept in constant motion of an irregular nature at a rate sufficiently rapid to prevent any particular point from being in one position long enough to be visible to the eye, the microscope image reappears without any apparent deterioration with the advantage that it is viewed by means of large bundles of rays.

Fig. 63.



Mr. Gordon by this means employs eyepieces which take the form of a complete microscope, and which magnify as much as 100 diameters.

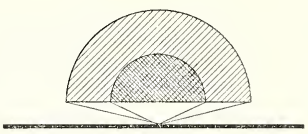
But the decision as to the best method of increasing magnifying power is influenced mainly by the important question of aperture.

The numerical aperture of the eyepiece does not concern us, it can be made with sufficient aperture to admit all the rays that are provided by the object-glass. The numerical aperture of the object-glass is the point of importance.

To what extent the resolving power of a microscopical object-glass will be increased by Mr. Gordon's topstop or other contrivances which may be invented in the future, has yet to be seen, and such innovations may modify the following remarks, but it may be stated in general that a well made object-glass forms an image which has portrayed in it structure to a fineness and with a distinctness which primarily depends on the aperture of the object-glass. If it has an aperture of ·5 N. A., the image may be expected to have depicted lines separated by about 1-40000th of an inch; such lines can be rendered readily visible by a magnifying power of 250, and an eyepiece,

which, used with this object-glass, gives as much magnifying power, may be used. A higher power eyepiece would show the same structure on a larger scale, but would not show finer structure, because finer structure does not exist in the first image formed by the object-glass; therefore, when it is desired to observe finer structure the power must be obtained by means of a different object-glass, in which the numerical aperture has been increased. This again points to the advantage that is gained by increasing power by means of the object-glass, and not the eyepiece, and lenses can be constructed up to a focal length of about 1-16th of an inch, in which as the power is increased, so the numerical aperture can be also proportionately enlarged. At about this point, however, when lenses of a higher magnifying power than 1-16th are made, the aperture has to be reduced, because the front lenses of these very high-power lenses must be small. Fig. 64 shows that if a certain practical minimum of closeness must be maintained

Fig. 64.



between the object-glass and the object, in order to provide for a thin cover glass and a minute working distance, the smaller the lens the smaller is the angle that it can collect from each point of the object. Lenses with a focal length of 1-75th of an inch have been made, but they had a smaller numerical aperture than modern 1-12th lenses. The aperture theory influences the question, therefore, in this way that high eyepieces should only be used to increase magnification after the object-glass of maximum aperture has been reached.

To summarise this matter:—1. High-power eyepieces magnify the errors of the optical corrections of the object-glass, and high-power object-glasses can now be made with nearly as perfect corrections as low powers.

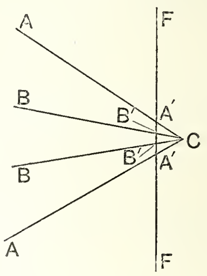
2. High-power eyepieces rapidly reduce the illumination. This can, however, be augmented by the use of a more powerful light.

3. High-power eyepieces by reducing the size of the emergent pencils of light show up defects in the instrument or the observer's eye. This can be remedied by the use of Gordon's Oscillating Screen.

4. High-power eyepieces can show no more detail than exists in the first image formed by the object-glass.

From which it may be concluded that the eyepiece used should always be a low power. Practice has placed the maximum at about × 10, until the 1-12th or 1-16th oil immersion is reached, in which case the maxium aperture in the object-glass has been reached, and the only way then to increase magnifying power without sacrificing aperture is by means of the eyepiece. I consider that it has been somewhat too hastily assumed that an extremely high power such as 1-75 with a lower aperture than the maximum may not have some advantages for special work that might justify its existence. When it is required to distinguish isolated lines or dots such as flagella, which are visible with a much lower numerical aperture than is required to depict structure, it may quite well be that some advantage would accrue from in-

Fig. 65.



creasing the power even to this extent by means of the object-glass instead of the eyepiece, but the use of such a lens would be limited to a restricted field of research, and it may be safely stated that 1-12th to 1-16th object-glass is the highest power that is generally useful.

The subject of aperture in the object-glass and its dependence on the diffraction theory has been somewhat fully treated in Lecture III. Intimately connected with this subject is the question of penetration or depth of focus, that quality which depicts at the same instant more than one exact plane of the object if not sharply yet with moderate distinctness.

The penetration of an object-glass is dependent on aperture, for as the aperture increases so the depth of field diminishes, and the gain in resolution by increased aperture involves a loss in penetration.

A simple diagram will explain this. Suppose the plane F F (Fig. 65), is the focal plane in which the image of one layer of a thick object is being formed—the image of the layer

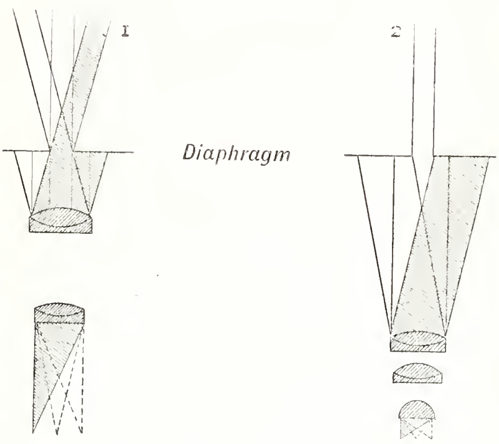
in this object immediately to the right of this will be formed in a plane C to the left, and will be out of focus. If, however, the position C is only a very small distance out of focus, and if the image is being formed by a narrow angle cone of light, B B, the appearance of a point viewed in the focal plane, F F, will be that of a small disc, of which B′ B′ is the diameter, which may be so small as to appear as a fairly sharp point, and the depth or penetration may be sufficient to allow both layers of the object to appear sharp. If, however, the image is being formed by a wide angle cone of light, A A, the appearance of a point viewed in the focal plane will be a large disc, with a diameter A′ A′, which would be too long to appear as a sharp point. This illustrates the fact that as the angle of light by which the image is formed increases, the power of seeing more than one layer of an object at a time decreases, and this angle by which the image is formed depends on the angle of the light entering the object-glass, or the aperture of the object-glass. It should be clearly understood that the angular aperture, or numerical aperture of an object-glass describes the angle of the cone of light collected from each point of the object and not the angle of field. The term angle as used with a photographic lens denotes the angular field of the view, and the two are sometimes confused. The angular aperture of a microscope corresponds with the rapidity or focal aperture of a photographic lens, and not the angle.

Mr. E. M. Nelson, who is probably the most expert living microscopist, has pointed out that the depth of focus of a high-power microscope is really the fine focussing adjustment. The fine adjustment in the hands of a skilled observer is in constant motion, focussing first to one place and then to another of the object under examination, by this means a perception of depth is obtained which could never be given by an object-glass fixed in one focus. Therefore for visual work, although large aperture lenses possess but little depth or penetration, its absence is not often noticed; but in microscopic photography depth of focus is a subject of great importance.

The penetration that is obtained by means of the fine adjustment is not admissible in photography. For this reason it is desirable in photo-micrography to use the smallest possible aperture that will display the structure in order that more than one exact plane of the object shall be in focus on the plate. The most satisfactory method is for the photographer to be provided with an Iris diaphragm behind his object-glass with which to cut down its aperture.

Such a diaphragm screwed in above the object-glass serves well with low powers (Fig. 66, 1), but when high powers are used the diaphragm thus placed is so far away from the actual lenses of the object-glass that the illumination is rendered unequal at different portions of the plate. Fig. 66 (2), shows that the oblique bundles of rays may be almost entirely obliterated, and the diaphragm should be specially mounted close to the back lens of the object-glass. This has been done with great success. The best method of dealing with the difficulty would be by reducing the aperture at the other end of the microscope

Fig. 66.



and placing an Iris diaphragm in the plane of the Ramsden circle, but this plan is sometimes inconvenient unless the microscope is specially constructed. For low power photo-micrography the diaphragm to cut down the aperture may sometimes be placed with advantage in the front of the object-glass.

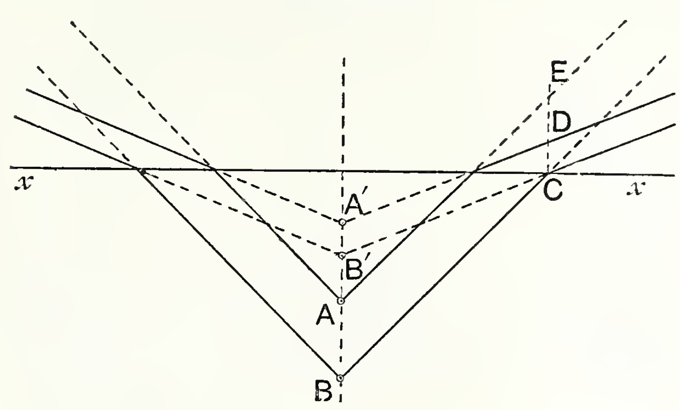
It is, perhaps, not self-evident why photographs should be required to show more than one exact plane of the object, but when the surface markings of solid grains such as pollen are to be shown, the matter is of great importance.

A most interesting research into the causes that make certain plants turn towards the sun required this quality of penetration in the microscope. The investigation led to the belief that certain cells in plant structure were lenticular and acted as small burning glasses, focussing numerous images of the sun upon the layer of cells at a lower level,

the action of which, by heating this layer of cells caused the necessary twisting action to produce the observed motion. By suitable arrangement of lighting it was shown that each cell, acting as a lens, produced a tiny image of a cross placed below the stage at a slight distance behind it, and it became necessary to produce a photograph which showed not only the cell but the picture formed by its means, and this was done by reducing the aperture of the microscope object-glass in the manner indicated.

Another point of interest with reference to penetration, is that it is increased when the object being examined is immersed in a highly refracting medium. This can be explained by reference to Fig. 67. If the

Fig. 67.



medium below the line X X be the same as the medium above the line, the objects A and B will appear to be at the depth A B from one another, but if the medium below the line X X is of a higher refractive index than that above it, the rays of light from A and B will be refracted on emergence into the air, and will appear as if they existed at A′ and B′, instead of A and B. It is evident that A′ B′ is less than A B, for A B equals E C, and A′ B′ equals D C. Thus the objects A and B appear to be closer together than they really are, and the object-glass has a better chance of focussing them both at once.

So it is that an object of considerable thickness can be photographed better when mounted in balsam than when mounted dry. It has been stated that an oil immersion lens gives greater depth of focus than a dry lens, but that is not necessarily so, it is the object itself that should be embedded in the highly refracting medium.

In the case of the examination of metallurgical specimens, illuminated by top light, it is inadvisable to mount these in a highly refractive medium under a cover-glass, because of the glare caused by reflection from the cover-glass, and the use of oil immersion lenses of even moderate powers, although no additional aperture is thereby obtained, has for this reason a great advantage.

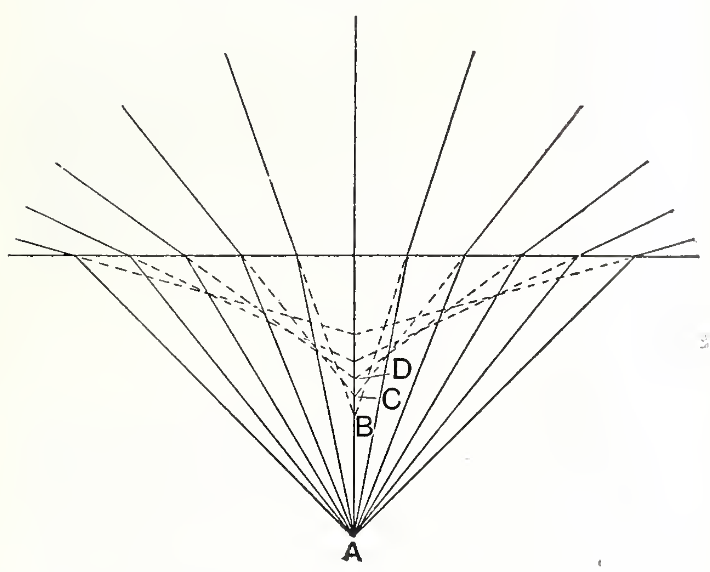
Photography of large anatomical specimens is in this respect more satisfactory when they are immersed in a fluid than when they are suspended in air, and the higher the refractive index of the fluid in which they are embedded the greater the ease of producing sharp photographs of portions which are not all in the same plane.

By the kindness of Dr. Albert Gray, of Glasgow, I am able to show you a photograph of the internal ear photographed on this principle. The ear is prepared by first dehydrating the specimen, then embedding in celloidin and paraffin. Decalcifying the bone and carefully dissecting out the matrix, after which, the paraffin being dissolved out, the whole of the delicate membranes are revealed. The specimen is almost as wide as it is long, and yet, owing to its being placed in a fluid and photographed with greatly reduced aperture, the entire object is clearly photographed. A very beautiful series of stereoscopic photographs of his specimens are published in Dr. Gray's recent work; these were obtained by making two photographs in succession, the trough containing the object being rotated a definite number of degrees of angle, so that each photograph of the pair depicted the object as seen at the two different angles required to give the stereoscopic effect.

A question which greatly influences the perfection of images formed by high powers is the optical effect of the cover glass on the performance of the microscope. In the second lecture the meaning of spherical aberration was explained, and it was shown that light refracted by a spherical surface did not focus to an exact point; that statement may be extended to a flat surface which may be considered as a spherical surface of infinite radius of curvature; it also has aberration. Suppose an object A (Fig. 68) to be mounted in Canada balsam under a cover glass, of which the horizontal line represents the upper surface, light emitted at all angles from A does not, after it has emerged into the air, proceed as from an exact point, but from different points, B, C, D, according to its obliquity. Thus a microscopic object-glass must be corrected in such a manner that it will neutralise this aberration of the cover-glass. An increase in the thickness of the cover-glass will increase the aberration, and dry lenses are usually made to correct the

aberrations for a particular thickness of cover-glass, generally 6-1000th of an inch. To obtain the best results, cover-glasses of the thickness for which the lens is corrected should always be used, unless the object-glass is provided with a correction collar. This is a revolving ring adjustment by which the correction of the object-glass can be altered, by altering the distance between certain of the component lenses, to render it suitable for different thicknesses of cover-glass, the collar being graduated with divisions which correspond to the thickness. Homogeneous immersion lenses do not require any such correction, because the light from the object, A, passes into the lens without refraction at

Fig. 68.



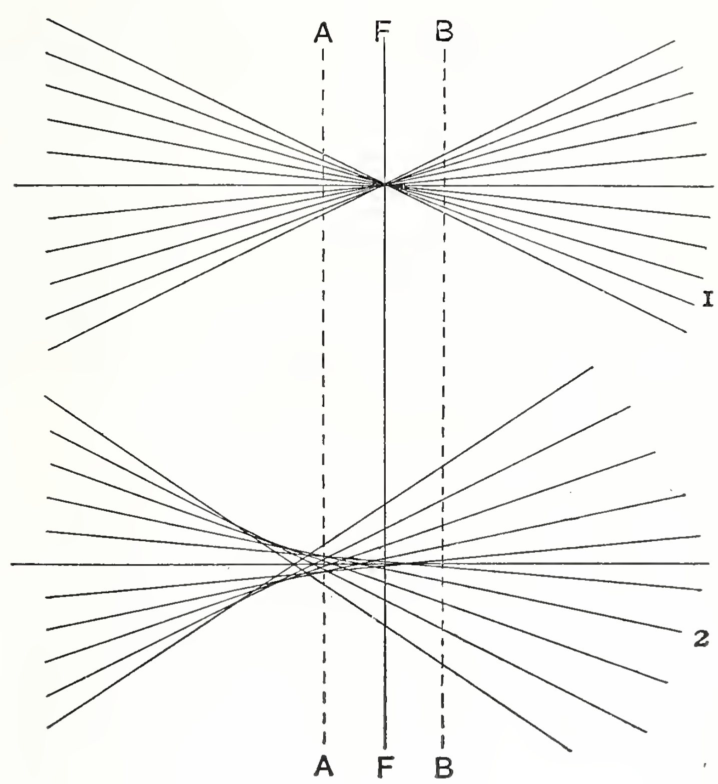
the surface of the cover-glass, and therefore no aberration takes place. This is one reason why in the hands of an unskilled observer an oil immersion lens produces better results than a dry lens. Few who have not carefully investigated the question realise how injurious to the performance of a high-power dry lens is the use of a cover-glass of incorrect thickness, or with a low-power lens, of thick troughs of fluid.

The method by which a lens possessing a correction collar may be adjusted by observation is not understood by most microscopists. It is not usually possible to pull a mounted object to pieces in order to measure the thickness of the cover-glass, but if the lens in use is one in which the graduations on the collar represent accurately the thickness of the cover-glass, then by means of a microscope which possesses a graduated milled-head to its fine adjustment, the thickness of the cover-glass may be measured.

Dust on the outer surface of the cover-glass having been focussed, and the graduation on the slow motion milled-head having been noted, the slow motion milled-head should be turned till dust on the lower surface of the cover-glass is focussed, and the difference in the focus, multiplied by the refractive index of glass, $\frac{3}{2}$, gives the thickness of the cover-glass.

This, however, is not so good a method as one which by direct observation of the image shows that the correct adjustment has been made. To explain the method on which this observation is carried out, let us examine Fig. 69, which shows at (1) the course of a

Fig. 69.



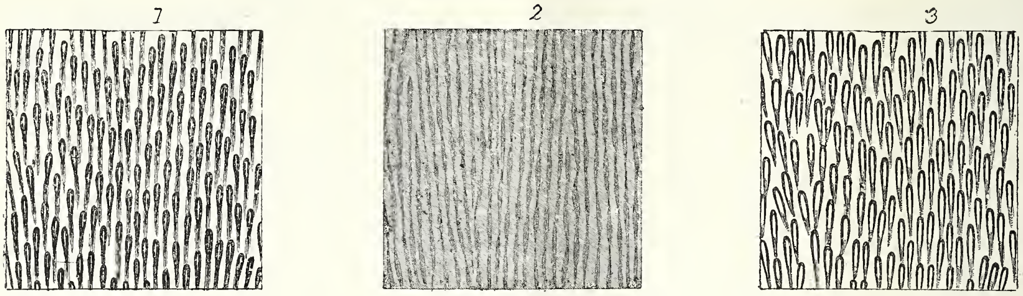
bundle of light of a corrected lens system, forming an image of a point where all the rays pass exactly through a point. (2) Fig. 69 shows an image being formed by a lens system that is incorrectly adjusted and in which all the rays do not come to the same point. Now it is evident that if the image formed at F (1) be examined at the points A and B, instead of at the true focus at F, an identical appearance will be seen on one side of the focus to that seen on the other—in both cases a disc of light of equal brilliancy throughout, and the disc at A will be as bright as the disc at B. Such evidently is not the case at the lower diagram; at (2) the image at A is a small and very intense disc; the image at B is a large and diffused patch, and the appearance on each side of the focus is quite different. This method of examining a point image is considered by opticians to be the most delicate known method of detecting any error in spherical aberration. To focus rapidly above

and then below the focus, and compare the two appearances, forms a means of detecting errors much too small to be measured, and it is upon this principle that the adjustment of a microscope object-glass should be accomplished by actual observation.

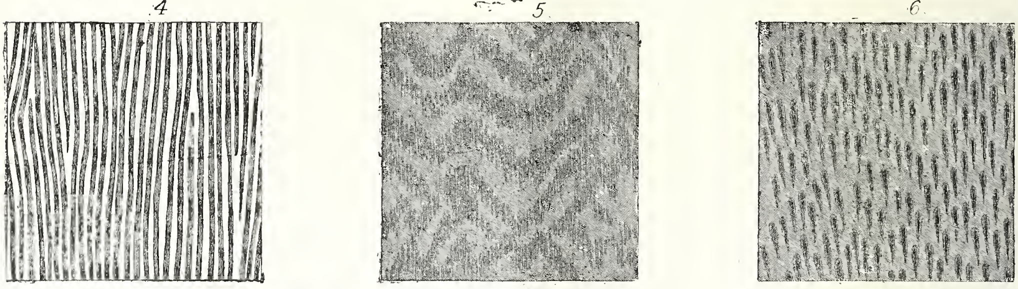
If a minute mercury globule be placed on the stage of the microscope and a small source of light be placed so as to illuminate it, a very minute image of this source of light will be reflected—an image so small that it resembles, to some extent, a mathematical point. With such an object the ideal conditions are obtained for making the correction of an object glass; the collar can be turned until the image of a point on each side of the true focus appears as an equally illuminated disc of light. Mounted specimens do not, however, contain conveniently-placed mercury globules, and some portion of the object itself must be chosen by means of which to make the adjustment. As a rule a black speck can be found in the object, which is so small that it approaches the size of a point, and by examining the manner in which this disappears from view as it is put slightly out of focus on either side, the lens can be accurately adjusted. The appearance should be exactly the same on either side of the focus when the adjustment is correct, it will change on the one side into a dark ring or disc, and upon the other side it will instantly vanish into mist if the adjustment is not perfectly correct, and by noting on which side the image remains, and on which side it instantly disappears, it can be found by a few experiments in which direction the correction collar should be moved to make the required correction.

Upon the same principle the object-glass may be corrected by examining the image of a fine line or hair, which is a row of points. If the lens is not correct the appearance on opposite sides of the true focus will not be identical—on one side the image will be retained as an indistinct image, on the other it instantly vanishes into mist.

Fig. 70.



PODURA SCALE, AS A TEST.
Each Square = .001 of an Inch; X 1,300



A scale of the small insect known as the *Podura* (*lepidocyrtus curvicollis*) forms the most sensitive test of the correct adjustment of a microscope object-glass that is known, and for this reason is used very largely by opticians as a test of the spherical aberration of the central zones of a high-power object-glass. The beautiful quill pattern which covers the scale suggests that a series of quills in the shape of interrogation marks are attached to the surface of the scale, but this is not the case and the appearance is probably due to corrugations on either side of the scale which viewed above one another produce the effect which is observed. Fig. 70 shows at (1) a portion of the scale in correct focus viewed

by a lens in perfect adjustment; at (2) the appearance on both sides of the focus viewed with the same, and at (3) the appearance as it is just going out of focus on either side; (4) and (5) show the two different appearances, one on either side of the focus, when the object-glass is out of adjustment; and (6) shows the nearest approach to a sharp image that can be obtained with a lens thus uncorrected.

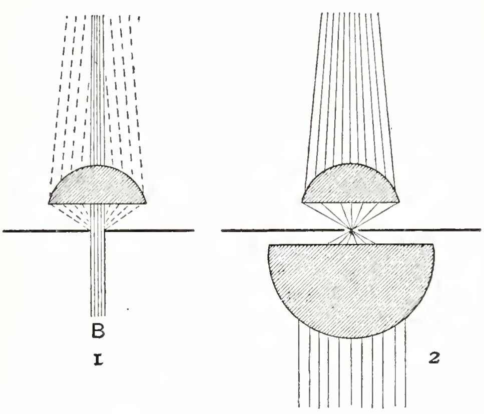
The reason why the *Podura* scale forms such a remarkably fine test is that the two appearances on either side of the focus of an uncorrected lens are both different and distinct patterns which change into one and the same pattern as soon as the lens is adjusted.

It is also important to remember that an object-glass will always give better results with a microscope of the correct length of tube for which it has been manufactured, although this, except for the most critical examinations, is of considerably less importance than the correct thickness of the cover glass, and need not be strictly adhered to when low and moderate powers are employed. I have found by experiment that an alteration of one-thousandth of an inch in the thickness of the cover glass when using a particular high-power dry lens was equivalent to an alteration of 17 inches in the length of the draw tube; but we need not for this reason conclude that the length of the draw tube has no influence on the correction, even though it may be an influence that is frequently exaggerated. Its importance becomes apparent with lenses of over one-sixth inch power, and the point at which the correction is perfect can be observed by the same means as those employed in examining the cover glass correction. To some extent the error of a slight variation in the thickness of a cover glass can be corrected by pulling out or pushing in the draw tube of a microscope.

It is necessary to consider in some detail the illumination of the object which is being examined. This question is one of prime importance. There was a time still comparatively recent when refinements in illumination were scoffed at by many classes of microscopists. In spite of the fact that fifty years ago high power illumination was carefully studied by the most capable observers, they were derided at large as diatomaniacs, and it is only within quite modern times that the advantages of special illumination have been recognised. A tour through the laboratories will carry conviction that, even now, the question of the best illumination seldom receives sufficient attention. The remarks which I shall make on this subject will not be so much in the nature of a theory as could be desired. The subject is not sufficiently understood; its theory will, no doubt, be evolved when the actual laws of diffraction which govern the theory of high power vision have more thoroughly soaked into the microscopical world. At present all that can be done is to state some of the results which experience has determined.

The illumination of very low powers, the illumination of opaque objects, and the so-called dark ground illumination, are all subjects of great interest, but time will not allow of the treatment of the whole question, and I propose to confine our attention to the manipulation of high powers, because that

FIG. 71.



is the branch of microscopy where the quality of the illumination produces such a vast difference upon the quality of the image.

Suppose, in the first instance, that a regular structure, such as a grating or a diatom, be placed upon the stage of the microscope, and viewed by means of a high power. Theoretical considerations have pointed out that that fine detail will not be resolved unless the object-glass can collect a large angle of light from each point of the object, so that the image may be produced by wide angle cones of light.

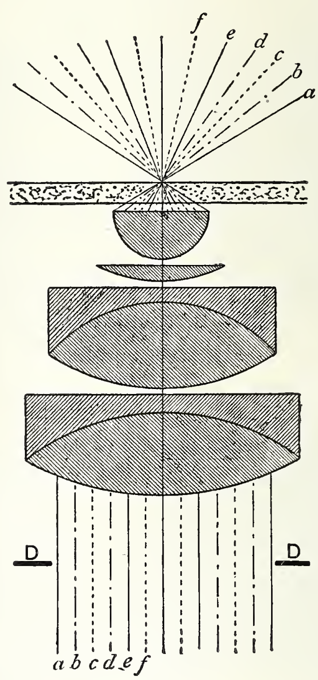
If a beam of parallel light, B, Fig. 71 (1), from the mirror of a microscope be thrown from below through the grating, the only direct light which passes into the microscope is the narrow beam, B, but a certain amount does not proceed in straight lines, and is diffracted in a fan and enters the object-glass at oblique angles. In the case of a regular structure, such as a grating, the

amount of such light is very considerable and has quite sufficient intensity, compared with the direct light, to make the beam which enters the microscope from each point approach to a homogeneous wide angle beam, and the diffusion discs or antipoints are, in consequence, small, giving a good image showing fine detail. It would, however, suggest itself that if the illumination of the object is formed of rays which are thrown through it in all directions, Fig. 71 (2), the brilliancy of the oblique rays being as great as the direct light, the beams forming the image are solid homogeneous cones, and might be expected to give a more perfect image. This view is confirmed by experience. Fine gratings, such as Grayson's rulings, can be seen when illuminated with a solid cone of light, which are invisible when only parallel light is employed. In the case of irregular structures, where the intensity of the light, scattered by diffraction, is much less intense compared with direct light, the difference caused by illumination is more marked. In order to produce this oblique illumination, the so-called substage condenser has been devised. In principle, it is a microscopic object-glass turned the wrong way round, and placed below the object. It is made to throw a solid cone of light of great angle through the object into the object-glass. It is made of moderately low power so that it will focus through the thickness of an ordinary slip, but should have a very large aperture in order to illuminate the object with a cone of light nearly as large as the aperture of any object-glass to be used.

Fig. 72 represents such a condenser, provided with an Iris diaphragm at D D, below the lenses. The light which enters the margins of the condensers forms the most oblique shell of emergent rays, the light which enters the centre of the condenser forms the most nearly parallel portion; consequently reducing the aperture by closing the Iris diaphragm, D D, reduces the angle of the cone by which the object is illuminated, and enables a cone of any obliquity to be used. Stops with apertures of different shapes or in different positions placed below the condenser enable definite isolated beams or rings of light to be used, and thus a perfect control of the light is obtained.

From the earliest days it has been considered by the most skilful English microscopists that a substage condenser should be always used with high powers for the illumination of transparent objects. It is within my own memory when, especially on the continent and among the less expert in this country, it was deemed an unnecessary refinement, but it is now universally admitted to be a necessity. It has also always been considered by the best English observers that such a condenser should be achromatic and, approximately, as well corrected as a microscope object-glass. This is still considered unnecessary by many, but every year the advantage of a highly

Fig. 72.



corrected condenser for the delineation of objects which are on the limit of microscopic resolution becomes more widely appreciated.

The microscopist owes a debt of gratitude to Mr. E. M. Nelson, amongst others, for his laborious work extending over 20 years in working out the *pros* and *cons* of different methods of illumination, and until further work has been done the result of his labours may be taken as the best guide for producing so-called critical illumination. The condenser should be achromatic and aplanatic to the highest possible degree. If a condenser is corrected to give an aplanatic image of a source of light, 10 inches from it, the source of light should be placed with but small variation at that distance, in order that as perfect an image as possible may be projected upon the object, and to give the finest results the image

should be exactly focussed upon the object being examined.

It is not clear why this should be so; but it suggests the idea that the object should be made to resemble as nearly as possible a self-luminous body giving off light equally in all directions. The condenser should be accurately centred so that it is exactly concentric with the optic axis of the microscope. As different object glasses are found in practice to differ slightly in this respect, the microscope sub-stage should be provided with a centreing adjustment by which the condenser may be centred for each lens; and now arises the important question as to the angle of the cone of light which should be thrown upon the object. Mr. Nelson devised a most interesting experiment, which has determined the matter so far as such objects as ruled gratings are concerned.

Examining a series of Grayson's rulings, which vary in steps from 10,000 to the inch to 60,000 to the inch, an object glass was employed with an aperture sufficient just to resolve the finest lines, and a solid cone of illumination was employed. It was found that if the cone of light illuminating the object was of such an angle that about $\frac{3}{4}$ to $\frac{7}{8}$ of the aperture of the object glass was used, so that in looking down the microscope tube when the eye-piece was removed the back lens of the object glass appeared to have about $\frac{3}{4}$ to $\frac{7}{8}$ of its back lens filled with light, the best resolution was obtained. Increasing or decreasing the illuminating cone spoilt the resolution. It seemed curious that the maximum cone of illuminating light could not be used, and it was suggested that this might be accounted for by some imperfection in the extreme edges of the lens or in reflections from the edges of the cells in which the lenses were set; but to settle this point an Iris diaphragm was introduced behind the object glass, and the aperture was slightly reduced; the 60,000 line ruling could now no longer be resolved, but the 55,000 could still be seen, although only when the aperture of the condenser was reduced to about $\frac{3}{4}$ to $\frac{7}{8}$ of the reduced aperture. This process was continued with smaller apertures and coarser gratings with the same results throughout, showing that the best resolution was always obtained with an illumination of about $\frac{3}{4}$ to $\frac{7}{8}$, the maximum cone of light which the object glass would admit. Such complete proof cannot be given as to the best illumination of objects of a different nature, but, as regards diatoms and stained histological specimens, experiment seems to show that the same method may probably hold good. There is another class of objects, to which I shall refer, where a different mode of illumination is probably superior.

As to the best form of illuminant, Mr. Nelson wrote (in 1884) that he finds direct sunlight the best possible, but too dangerous for visual use, diffused daylight being the worst, and quite unsuitable for critical high-power work. The filament of an incandescent light is too small to illuminate a sufficient area when in focus on the object. A Nernst or arc lamp used in front of a screen with a small ground glass, which makes a radiant object, forms a good illuminant. An incandescent mantle, unless distributed in this manner, is bad, because when in focus the meshes of the fabric of the mantle interfere with observation. Probably the best simple illuminant is the edge of a flat-flame paraffin lamp.

Mr. Gordon has made use of a solid glass cone, with an illuminant at the large end. By successive internal reflections along its surface the light emerges from its small end at all angles, thus creating a small surface, which acts somewhat like a self-luminous body.

This subject is one upon which it is not safe to dogmatise; it would appear that a radiant surface of perhaps $\frac{1}{2}$ inch to $\frac{3}{4}$ inch high, and not less than $\frac{1}{8}$ inch to $\frac{1}{4}$ inch wide, is the best, and that the mode of its production is unimportant,

In our last lecture we have seen that the images produced by high-power microscopes are marred in their sharpness by the diffraction of light; we have also seen that the amount of diffraction is dependent on the wave length of light. The longer the wave length of light the larger the diffraction discs which render the image indistinct. It might therefore be predicted that the use of light with a short wave length would tend to produce sharper pictures and increase the resolving power of a microscope. Green or blue light has a shorter wave length than red or yellow, white light compromises light of all wave lengths from red to violet. The yellow or yellow-green light is so much more intense to our perception that the effect of the less brilliant light in the dark green, blue, and violet is overpowered, and we should expect to find that the use of a pure green or blue light of short wave length for microscopic illumination should produce better results than the use of red, yellow, or even white light.

This is fully confirmed by experiment. The use of green or blue monochromatic light for

visual work and of ultra-violet light for photography gives better resolution.

The best method of producing monochromatic light is undoubtedly by splitting white light up into a spectrum by means of a prism or diffraction grating. Any portion of the spectrum can then be selected. As a rule the blue end of the green is the best portion to choose, because blue itself is irritating to the eyes, and but few artificial illuminants are sufficiently rich in the blue rays to give the intensity required.

A simpler method of producing monochromatic light consists of using white light, and cutting off all but one colour by a screen. A saturated solution of acetate of copper makes an excellent blue-green filter, although the light which passes through is not so pure in colour as the spectrum colour.

The advantage of monochromatic short wave length illumination is so marked that every microscopist should be provided with a monochromatic light filter which should always be used with high powers, except where the colour of a specimen is a matter of importance in his investigations.

Mr. Gifford has devised a filter which is slightly better than the acetate of copper solution, and certain stained gelatines are made which, except for the fact that they are much more opaque than the above solutions, are some of them satisfactory. Certain forms of green signal glass give fairly good results.

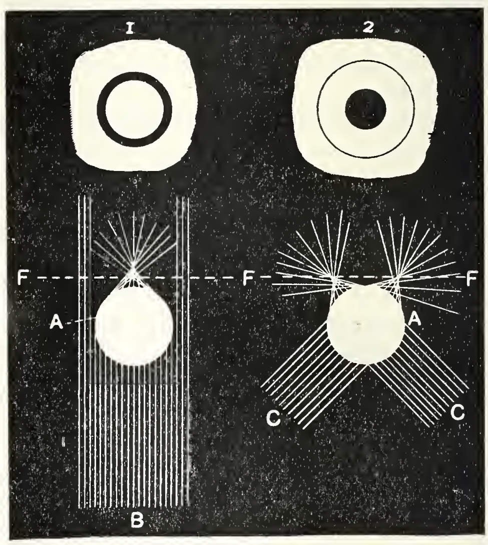
Such is the outline of what is called critical illumination, but it is certain that different classes of structure require different illumination. Sir A. Wright has drawn attention by a series of ingenious experiments to the appearances caused by highly refracting objects.

Unstained transparent objects can only be seen by the quality which they possess of either refracting or reflecting light, and a careful repetition of the experiments described in Sir A. Wright's book on the microscope, will well repay the student. By means of glass balls and beads, examined against different coloured backgrounds, the optical effects produced by transparent highly refracting bodies are demonstrated, and a continuation of his line of investigation leads to the conclusion that such transparent bodies are rendered visible only when the correct methods of illumination are employed.

It has been demonstrated experimentally that minute unstained transparent micro-organisms can be rendered visible by means of illumination, which consists of a fine direct pencil of light. A tiny aperture, or pinhole, placed behind the condenser, or better still behind the object itself, allows only a fine parallel beam of light to illuminate the object, and by this means a ring of black, near the margin of the object is produced, giving an indication, if not of its exact shape, at any rate of its presence and movements.

A diagram (Fig. 73) will illustrate the point. Suppose A to be a highly refracting ball enclosed in a less dense medium. If this is illuminated by means of a wide angle sheath of light as at (2), light will pass through it and will be focussed to a ring image at the plane

Fig. 73.



F F, and will give the appearance of a small central black spot with light all round it. If a fine parallel beam as in (1) is thrown upon the ball, the central light will pass through and be conveyed, not to an exact point, but forming at the plane F F the appearance of a bright disc surrounded by a dark outline, so that the ball is rendered visible by means of the black margin where no light passes through.

If a solid cone which includes light in all directions passes through the ball, there is no means by which it can be rendered visible, as the parallel light illuminates the central portion and the oblique light the marginal portions of the image, and a continuous bright picture is observed. It would be premature to say that a parallel beam of light, as now used for this purpose, is the best. Certainly, if such a small fine beam of light for illumination is employed, it is not what is known as critical illumination, and the size of

diffraction discs may be expected to be large, but it must be remembered that the object, if it consists of highly refracting bodies like little lenses, may be itself distributing light which it receives as a fine beam in the form of a wide cone. This wide angle cone may be sufficient to fill the aperture of the object-glass, and the diffraction disc will then be reduced in size.

It is a matter of great importance to those who study living micro-organisms that further study should be devoted to this question. The difficulty of observing unstained specimens is a serious drawback to research, and Mr. Gordon's suggested top-stop appliance might prove to be of great service in this direction, or the use of dark ground illumination, so that the objects may be seen by the light which they reflect, may be valuable.

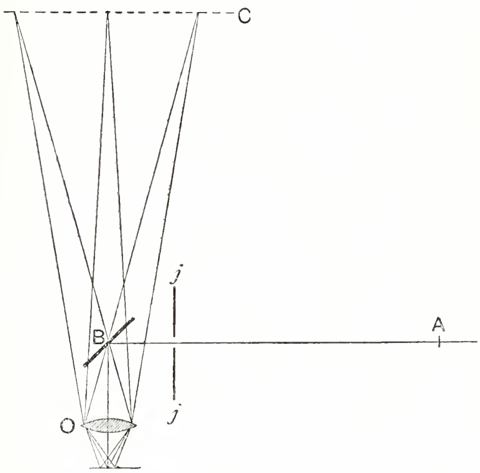
The employment of the Siedentopf apparatus for the examination of ultra-microscopic particles has directed attention to the use of dark ground illumination, and certain modifications of the Stevenson high-power dark-ground illuminator have been introduced, whereby object-glasses, such as one-twelfth oil immersion with a N.A.I., may be used for examining bacteria on a dark ground. A very powerful illuminant is required, and the light is condensed upon the specimen in a ring of such great obliquity that no direct light enters the instrument.

Before leaving the subject of illumination, the method of applying critical illumination to opaque objects may be described. In the investigation of metal surfaces with high powers, a reflector, either prismatic or transparent, is placed above the object-glass, and the illuminant is placed to one side of the instrument; in this case the object-glass itself takes the place of the substage condenser, and the same rules of illumination as those laid down for examining transparent objects should be observed. The light should be focussed upon the object. This requires that the illuminant should be placed at a point, A (Fig. 74), which is at a distance from the reflector, B, equal to that of the plane, C, where the image of the object is formed by the object-glass.

This plane is situated at about the centre of the eyepiece, and thus the distance A B may be readily found. If an Iris diaphragm *jj* be placed at that portion of the instrument where the light enters from A, the cone of illumination is controlled in exactly the same manner as by the Iris diaphragm of a substage condenser, but the centreing of the light requires very careful manipulation. Monochromatic light may be used and a similar form of illumination is obtained as the critical illumination of transparent objects. The problem of illuminating opaque objects is not the same as that of transparent objects, but at any rate for flat polished metal surfaces experience seem to show that this method of critical illumination has advantages.

During the progress of these lectures we have seen how the lenses of which the microscope is composed have been built up and modified to form a suitable instrument for microscopic vision. We have seen how the defects of simple lenses have been corrected with such perfection that further improvement in this direction is not likely to

Fig. 74.



be considerable. We have then seen that there are errors caused by diffraction which put a limit to the use of the microscope, and that the best results are only obtained when great attention is paid to the illumination. It is interesting to speculate whether we are likely to see any great advance in the power of the instrument.

Herr Seidentopf's method of demonstrating the presence of ultra microscopic particles apparently opens up a new line of research which has certain limited applications and it may quite well be that the next generation will witness startling developments. Such are purely matters of conjecture, but those who have carefully followed the course of these lectures will, I think, have gathered the opinion which I have endeavoured to inculcate that there is at the present time a most important problem to be solved. Taking our microscope as we now find it, have we yet learnt how to use it to the fullest advantage?

The problem to be solved all centres round the question of what is the best method of illumination. We hear a great deal about the testing of microscope object-glasses. Scarcely any two observers agree as to the relative merits of a particular lens. A microscopist, who is skilled in the different methods of illumination will see more than another, even though his lenses are intrinsically less perfect. The fact is we do not yet know with any certainty the best methods of illumination for high powers. We do not know with any certainty how closely the images that we see represent the actual objects.

This problem of illumination and the correct interpretation of the images obtained has become of such importance with reference to the study of disease, that I think it should be seriously considered whether it is not necessary for some institution or public body to institute a permanent research into the matter of illumination, to select capable men who may devote their whole time to experimenting upon the use of the microscope with a view to determining the exact conditions under which the instrument may be used to the best advantage for different purposes. In the past, enthusiasm for the subject has induced many distinguished amateurs to undertake such investigations, but it is doubtful whether in the future worthy successors will be found to these eminent microscopists, and in view of the importance of this subject it seems advisable that the matter should not be left to chance.

SIXTH ORDINARY MEETING.

Wednesday, January 15, 1908; Professor FREDERICK THOMAS TROUTON, M.A., Sc.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Ashby, John Thomas, Edenholme, Hatherley-road, Kew-gardens, Surrey.
Bunau-Varilla, Phillipe, 53, Avenue d'Jena, Paris, France.
Chatterjee, Pasupatinath, The Palace, Burdwan, Bengal, India.
Cope, Mrs. Therese Elizabeth, 10, Connaught-mansions, Battersea-park, S.W.
Cox, Fred. J., M.I.Mech.E., 104, Park-street, Gloucester-gate, N.W.
Davidson, T. Gerard, 44, Great Russell-street, W.C.
Durham, Miss M. Edith, 116, King Henry's-road, South Hampstead, N.W.
Gilder, Ardeshir Nowroji, Parvati-building, Thakordwar, Bombay, India.
Gray, St. George, B.A., M.B., Senior Medical Officer, Calabar, Southern Nigeria, West Africa.
Griffiths, John Norton, 62, London-wall, E.C.
Jack, John W., 37, Queensferry-street, Edinburgh.
Krishnamackarya, M., M.A., B.L., Triplicane, Madras, India.
Lukis, Wilfrid Ravenshaw Fellowes, M.I.Mech.E., Rising Sun Petroleum Company, Limited, Nonai Installation, Aomori-Keu, Japan.
McClure, David Simpson, Bank of Bengal, Calcutta, India.
Maung, Maung, 7, Victoria-street, Bassein, Burma.
Midgley, Albert Henry, 86, Cranmer-road, Forest-gate, E.
Nicholson, Dr. Jonathan, Llanberis, Sandford-road, Bromley, Kent.
Pearson, Hugh, Rockend-terrace, Milngavie, Scotland.
Rodger, Robert, F.C.S., 54, Rostrevor-road, Fulham, S.W.
Sanderson, James, New Plymouth, New Zealand.
Spencer, Major Maurice, 2, Staff-quarters, Royal Dockyard, Woolwich.
Taylor, William Henry, A.M.I.E.E,, 15, Hampton-road, Forest-gate, E.
Turnbull, Herbert, M.I.E.E., 2, Myddleton-park, Whetstone, N.
Watts, George William, 63, Breakspears-road, Brockley, S.E.
Wicks, Joseph Thomas, 185, Fore-street, Edmonton, N.
Wright, Thomas D., Northampton Institute, St. John-street, Clerkenwell, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Astley, Reginald B., Acton Reynold, Shrewsbury.
Dos Santos, José Americo, M.Inst.C.E., Caixa 748, Rio de Janeiro, Brazil, South America
Hamilton-Gordon, Ernest Arthur, Fire Brigade Headquarters, Southwark, S.E.
Heaton, Noel, B.Sc., F.C.S., 20, Baker-road, Harlesden, N.W.
Jones, William Arthur, Electricity Works, Cathall-road, Leytonstone, N.E.
Richards, Richard Slome, Lakeside, Bourne End, Bucks.
Stamp, William Frederick, A.M.I E.E., 11, Brunswick-place, Stoke, Devonport.
Thorn, Cyril Hunter Robert, 42, Elm-park-gardens, S.W.
Whittick, Fred. G., Imperial Provincial College, Tsinanfu, Shantung, China.

The paper read was:—

SCREEN-PLATE COLOUR PHOTOGRAPHY.

By C. E. Kenneth Mees, D.Sc., F.C.S.

The growing interest in colour photography, which has been shown in this country, as well as on the Continent, for some years, has this year become more general in consequence of the introduction of the Lumière autochrome plate. This Lumière autochrome plate is representative of one of the most interesting methods of colour photography, and of the method which is most easily utilised by the unskilled experimenter. It seems desirable in this paper to discuss this method of colour photography in general terms, dealing not so much especially with any particular process, as with the conditions which are necessary for the obtaining of good results by what are now generally known as the screen-plate processes.

A screen plate is a plate in which the colour filters necessary for the taking and projecting of a colour image are incorporated in the plate itself, thus eliminating the necessity for external colour filters or for duplicate exposures.

There have been many claims advanced for screen-plate colour photography, on the one hand, there are those who have announced it as "real colour photography," implying that all other colour photography is unreal, and on the other hand, there are those who have announced, with equal confidence, that it is not colour photography at all.

It would seem to me that colour photography by means of screen plates, is simply the easiest method of application of tricolour analysis; it has the advantage that the ratio of exposures beneath the filters being fixed by the maker, the projection filters being fixed by the maker, the use of duplicate plates and complex cameras being disposed of, and it being possible to view the results without apparatus, it is a process essentially suitable for the unskilled worker.

The Basis of Colour Photography.

In order that any method of colour photography may be clearly understood, it is necessary first to consider the basis upon which colour photography has been developed. That basis is, that any colonr may be matched by a mixture of light of three different colours, these colours being chosen correctly as regards their spectrum composition, and then being adjustable in intensity until the colour is matched. This fact is an experimental one, and is independent of any theory of vision. If three isolated patches of the spectrum be taken, an orange-red, a blue-violet, and a pure green, then by mixing those three isolated patches, any of the primary or secondary colours can be matched; the only colours which cannot be matched being the pure colours outside the range, namely, pure monochromatic violet, which is so dark that blue-violet will match it quite satisfactorily, and pure deep spectrum red, to which the nearest match which can be obtained is orange-red, degraded with black. In fact, pure deep spectrum red is the only colour which cannot be sufficiently well matched by this method.

Colour photography can be accomplished by photographing coloured objects by means of the three primary colours, and then making positives from the plates so taken and projecting them by means of the colours with which the negatives were taken, super-imposing the coloured images. In order to photograph a blue-green object for instance, we make three negatives on plates which are sensitive to all colours of the spectrum, making the first negative through a filter which only transmits red, the second through a filter which only transmits green, and the third through a filter which only transmits blue; the blue-green object is recorded as a black deposit in the negative taken through the green filter, and as a black deposit in the negative taken through the blue filter, but inasmuch as the blue-green light was stopped by the red filter, the blue-green object will be represented by clear glass in the red negative.

On making positives from these three negatives, we get a black deposit in the negative corresponding to the red filter, and clear glass in the other two positives. If now we put these three positives into a triple lantern, putting in front of the positive taken from the red filter negative the same red filter as that which took it, and in front of the other two positives their corresponding filters, then the red light is stopped by the black deposit in the red positive, but the blue and green lights are sent forward on to the screen, forming a blue-green image.

We must distinguish this method of colour photography, which is known as the additive process, and is that used in screen plates, from the subtractive method of colour photography, which is that usually practised in the preparation of lantern slides or paper-prints by other methods.

If we wish to represent a blue-green object by a subtractive method, we should have

printed the red negative, in which we had no black deposit, in the complementary colour to red, *i.e.*, blue-green ; on the top of that we should have superposed a print from the green negative made in the complementary colour to green, *i.e.*, magenta. Since the green negative had a black deposit, there would have been a clear space with no stain in the place where the image of the blue-green object fell. In the same way, the print from the blue negative would have been made in the complementary colour to blue, namely, yellow—but since the blue negative was opaque where the blue-green object was, there would be no stain there, and consequently the blue-green print from the red negative would have the only stain, and the blue-green object would be rendered as blue-green.

It is important that this distinction between the additive and the subtractive methods of colour reproduction should be clearly borne in mind. The screen-plate processes are additive processes, and the conditions which apply to additive processes apply to them, so that it is to the additive processes that we must look for information with regard to the conditions which must be fulfilled in the formation of a screen plate.

The production of a screen plate resolves itself into the production of a very large number of small filters which are distributed over the whole surface of a glass plate. These filters being coloured to the requisite depths, orange-red, green, and blue-violet, should be so small that the individual units are invisible to the eye. This screen is then placed in contact with the sensitive film either by super-imposing on the screen an ordinary photographic plate, or by coating sensitive emulsion upon the surface of the screen plate itself. Now if a blue-green object be photographed on this plate, through the colour filters, and the plate be developed, the small blue and green sections of the screen will transmit the light from the blue-green object and produce black deposits beneath them ; but the red units of the screen will stop the blue-green light, and consequently the film beneath the red units will remain clear on development. If the developed film be now placed back in contact with the screen, in that position which it occupied during exposure (in the case of a film which is coated on the screen itself, this registration is, of course, unnecessary), the blue and green sections of the screen will be obscured by the black deposit, but the red sections will be clear, and consequently the blue-green object will appear a bright red. In the same way, a yellow object will obscure the film under the red and green sections, and will appear blue ; a pure green will affect the film only under the green sections, and the plate will show a mixture of red and blue, *i.e.*, it will be of a magenta colour, so that in general a complementary colour negative will be produced. This must now be transformed into a positive either by printing a positive from this complementary negative, or else by turning the negative into a positive directly after development by some such process as the permanganate reducer used by Messrs. Lumière. If we turn it into a positive, then our black deposits under the blue-green elements will vanish ; we shall develop a black deposit beneath the red elements, the light from the blue and green elements will be transmitted, and the mixture of these lights will reproduce our original object as blue-green.

Production of the Screen.

Forty years ago Ducos du Hauron suggested the production of a screen plate, as forming a simple method of colour photography, which was to consist of a sheet of transparent paper mechanically covered upon its surface with three kinds of coloured stripes or divisions. "Let us imagine," he writes, "that one covers the surface of the paper on the side where the colour stripes are imprinted with a preparation which gives directly, under the influence of light, a positive proof, and that one receives on its reversed side—namely, on the side not covered with stripes—the image of the camera. It will happen that the three single colours will filter through the paper and form each its positive print, *i.e.*, its print in light of the corresponding ray of colour, and the three prints will be formed with the same rapidity, in spite of the unequal degrees of actinism of the three simple colours, if one has been careful to give to each of these three sorts of stripes a relative translucency, inversely as the photogenic power of these same colours on the preparation employed."

This was in 1868, and it forms the basis of the screen-plate processes, the first of which was put forward commercially in 1895, when Professor Joly invented his system of screen-plate photography. Professor Joly ruled on gelatine-coated glass his sets of three lines, and placed the screens so prepared, in contact with the sensitive plate. After exposure, the plate was developed, and a positive made,

which was then again placed in contact with the screen, the result being a most satisfactory image in colours. The real difficulty of the Joly process appears to have been the difficulty of obtaining plates which should be regularly of the same sensitiveness. The compensating screen which fitted one batch of plates would not fit another, and this difficulty was sufficient to be a grave objection to the general application of the process.

Somewhat previously to Professor Joly's method, Macdonough had prepared plates by scattering over their surface small flecks of coloured shellac, and then fusing these flecks on to the surface. But Macdonough became convinced of the superiority of the line method, possibly mainly because of registration difficulties, and he founded the International Colour Photo. Co. with a view to the production of screens by machinery in large quantities. The plates were ruled with fine lines by means of celluloid wheels, from which coloured inks were deposited upon the surface of the plates; the process was very difficult, and the plates were extremely costly to make. Mr. G. E. Brown states, that one weak spot in the process was the difficulty of getting proper contact between the sensitive plate and the taking-screen in making the exposure, but that the company failed on account of the cost of the plates.

In the Sampolo Brasseur process, one of these line-screen negatives, made as in the Joly process, is separated into its elements by means of superposition on the line negative of a black and white screen in which the black lines are twice the width of the clear space; the whole plate being moved sideways on the plate used for making the positive, so that each line element is spread out to three times its width, the lines being printed in turn. From the three positives thus prepared prints are made by any of the usual subtractive processes.

In the Joly, Sampolo Brasseur, and the International Co.'s processes, the photographic film was separated from the screen. This has great advantages in the production of positives, but it involves difficulty in registration, and also, owing to the usually unsatisfactory nature of the glass which is used, considerable difficulty in obtaining sufficiently close contact. The difficulty of registration necessitates the use of regular screens, as it will clearly not be possible to register irregular screens, and consequently later experimenters have prepared plates with a view to the coating of the sensitive emulsion upon the surface of the screen plate itself.

Mr. Powrie, who has worked out his process in collaboration with Miss Warner, devised this process originally to overcome the difficulty of preparing line-screens by machinery. Mr. Powrie produces his line-screens by the following method:

A plate is coated with a mixture of bichromated fish glue and albumen, and is exposed to arc light beneath a black line screen in which the black lines are twice the width of the spaces. After exposure the plate is washed, the water washing away the unexposed fish glue and leaving only the deposit beneath the exposed lines. The plate is then dyed green, and the dye is mordanted home. The plate is then again coated with bichromated fish glue aud re-exposed beneath the screen, but the exposure is arranged so that the green lines are completely covered by the black lines of the line screen. This has been arranged in practice by placing the plate on the screen and twisting it in its frame by means of set screws until the moiré pattern vanishes; the plate is then moved at right angles to the direction of the lines, until the whole screen appears bright green, thus showing that the screen lines exactly fill the clear space of the black and white screen. The plate is moved by the width of one line and a half, so that it is completely behind the black line; it is now exposed again and the second line is dyed red. After re-coating, the plate is again exposed through the back without the black and white screen, the red and green lines serving as shields to the fish glue. After washing, this last coating is dyed blue, and the blue lines just fill the spaces between the red and green lines.

It will be clear that by this process we get a screen of which the whole coating is in one plane, and if the process is as cheap to work as might be expected, there is probably a considerable future for it. The lines can be made very fine, the production of finer black and white screens being accomplished in a similar manner. Thus, if a coarse line screen is taken, a bichromated fish glue plate is printed from it, and the lines turned black by a ferrotannic process; this plate is then replaced so that the black line is exactly in the middle of the black screen line after recoating: this gives us another screen plate of the same pattern as our first, but with twice the number of lines, and the process can be repeated almost indefinitely.

Another line-process has been patented by the veteran Du Hauron. In this, which is termed the Omnicolore Plate, two lines are printed in greasy inks crossing at right angles, the actual crossing point being, according to M. Hauron, avoided. The spaces are then filled up by a means of a water-colour which is repelled by the greasy ink.

One of the most unpromising of screen-plate processes at first glance is that which has first come on the market, the starch grain process of the Lumière Bros. One may almost imagine that, had the difficulties which must have occurred in the production of the starch grain plate been met by less resources and skill than those of the great Lyons factory, so difficult a process as the starch grain could scarcely have been utilised commercially; but those difficulties have been overcome, and the one process which is on the market is the Autochrome process. In this, the screen is manufactured by the following method :—

Grains of starch are taken and sorted until only those between certain limits of size are isolated. These are then divided into three portions and stained to give the requisite filter colours. They are then again mixed as completely as possible, and scattered on the surface of the plates, which are rolled to flatten the grains. After rolling, black is dusted on the plates to fill up any spaces which may occur, and the screen is covered with a medium to prepare it for receiving the film. The starch grains average between 1/1000 and 1/2000 of an inch in diameter, and when one considers the difficulties of the process, the mechanical perfection attained is astonishing.

A process which is stated to be nearly ready is that invented by Robert Krayn. In this process the screen consists of a sheet of celluloid made in the following manner :—

Sheets of celluloid are stained in the requisite colours, and are then placed on the top of each other and cemented together so as to form a continous block composed of sheets of red, green, and blue celluloid: a section is then cut straight through this block and a leaf is obtained which shows throughout its width the red, green, and blue lines which were originally, the leaves forming the block. The system in fact, is exactly that used in forming "Edinburgh rock." To make the Krayn mosaic screen these line-screens are again cemented together and form a block, and a section is now cut at right angles to the line direction. The colours of the Krayn plates which I have seen have been very good, but it is difficult to get the lines sufficiently fine. This involves the cutting of extremely thin celluloid sections; it must be remembered that the narrower the lines become, the finer must the celluloid be, otherwise the parallax error due to the thickness of the line will be appreciable, and it will probably be necessary to support the film on glass if it become so thin. Also, if the line is to be made very thin, it is necessary to dye the celluloid very deeply in order that the colours may be of the requisite intensity.

Dr. J. H. Smith has patented the production of screen plates by printing the units photomechanically in geometrical patterns.

Another method of making a screen plate is that which has been patented by Rudolph Berthon and Joseph Gambs. They suggest that transparent filaments should be used to make fabric by the ordinary weaving method, this being varnished on the plate and then coated with the emulsion.

C. T. Finlay has patented the printing on a plate of two separate sets of circles, the space left between them being filled in with the third colour.

H. W. H. Palmer has patented two methods of preparing screen plates. One is similar to that used by Macdonough. He covers the plate with small particles of coloured glass, mixed to produce a neutral grey, and then fused on by firing in a kiln. Another method he suggests is spinning glass filaments on to the plate, and then firing in the same manner.

The production of screen plates is, as these examples will show, possible of accomplishment in very many ways. The conditions of success, apart from the necessity of obtaining a satisfactory plate, also involve the question of cost of manufacture.

A method which I have employed for preparing screen plates, showing wide lines, for the illustration of this paper, is to coat a sheet of glass with bichromated gelatine on the ordinary coating machine, and expose this glass under a line-screen having the black line one-half of the width of the space. In this way two-thirds of the width of the screen becomes hardened, the lines covered by the black screen line remaining soft; this soft line is then dyed up with one of the many dyes which do not penetrate hard gelatine, and after drying, the plate is again coated with bichromated gelatine, the second and the third line being put on in the same way. This method of manufacture is quite simple with coarse lines such as were necessary for

illustrative purposes, about 15 to the inch, but I should doubt if it would be commercially practicable for small units.

It does not follow that the method which comes to the fore is easiest of production or the one calculated to give the best results; either of those things may be true or they may not. In order that a process may be commercially introduced, there is required not only the primary idea, but a great deal of patient working out, and probably a manufacturing house behind it, because in the end the production of anything of this sort is a question of commercial scale working, and only a factory can experiment on a sufficient scale.

Conditions for the Production of the Filters.

It was explained at the beginning of this paper that the screen-plate processes are additive processes of colour photography, and the importance of this fact becomes manifest when we consider the filters. The taking-filters for an additive process are the same for those of a subtractive process. The conditions then for the taking-filters are:—That the red should be a sharp cut filter transmitting the scarlet and orange to—say 5,800 A.U.—but not transmitting the green or blue. The green filter should overlap the red, and also to a somewhat greater extent the blue, though overlap on the blue side is not so important in an additive process as in a subtractive; so that if our filter extends from 6,000 to 4,800, we may regard it as satisfactory. The blue filter should not transmit red, and if the dye used in it absorbs the ultra-violet to some extent, there will be less difficulty in making the compensating filter. The blue filter should transmit from 5,000 to 4,000.

These then are the conditions for ideal taking-filters, but if the screen plate is to be turned into a positive, there will not merely be the taking-filters, but also the projecting filters; and for projecting filters the conditions are different. In order that strong colours should be obtained when using projecting filters, it is necessary that the spectrum cuts should be fairly narrow, and if possible they should not overlap.

Overlapping projecting filters will give distinctly washy colours, diluting pure colours with white; so that in manufacturing a screen that fact must be remembered; and in practice if we are to reverse our screen-plate and turn it into a positive, the filters must be a compromise between the taking and projecting filters. Probably the best compromise is that the filter zones shall touch but not appreciably overlap; this is realised in the "Autochrome" plate.

Testing the Filters.

The exact area of the filter zones may be easily found from the screen-plates themselves. It is possible to take micro-spectro photographs showing the absorption spectra of the filters. Thus by using an enclosed arc (barium being introduced into the arc to produce a line spectrum) focussed on the condenser of a microscope, with a one-tenth inch objective, and then a micro-spectroscope attached to a camera, I have been able to obtain spectrographs of the absorptions of the Lumière and Warner-Powrie filters. But another method is quite as satisfactory and very much less trouble. I have fitted in front of my spectroscope a small black wedge which gives a gradation of light along the slit, the variation in intensity running from 1 to 10,000, and consequently spectra photographed in this spectroscope show a series of hills and valleys, the summits representing the maxima of sensitiveness, and the valleys the minima. In order to find the spectral region of the filters, the screen plate is exposed in the usual way through the screen; after development, a complementary spectrum negative is obtained in which the area of the red filter is marked out by a blue-green patch, the area of the green filter by a magenta patch, and if there is any overlap, that overlap between the two is shown as violet. The area of the blue filter will be shown as yellow, and the overlap between the green and blue filters as a pure red. These spectra will also show, besides the spectral regions and the sharpness of the cut, the effect of imperfect filters transmitting undesirable portions of the spectrum, owing to the great fineness necessary in screen plates, which causes considerable difficulty in obtaining sufficient depth of colour in the plates to get satisfactory filters; this difficulty is one which has as yet hardly been realised, but it is one limiting condition for the fineness of the line. If the red filter transmits blue or violet, an extremely common defect, then the yellow representing the blue filter in the spectrum will not be a pure yellow but a yellow-green. In the same way, if the plate is sensitised far into the red, and the blue filter transmits extreme red, a fault to which nearly all blue dyes are prone, then beyond the blue-green of the pure red there will be a patch of pure green; and if the

green also transmits red this patch will be black. A patch of black in the blue-green region of the spectrum shows that the red is being transmitted there.

The practical effect of inaccurate filters is that if the red and green filters transmit blue, the defect which of all is most difficult to avoid, then pure reds will appear in the finished positive not to be reds at all but browns; and this brownish appearance of what should be scarlet shows at once that the red and green filters are transmitting blue. The magentas will in the same way appear purplish, and pure greens will tend towards a bluish green. Transmission of the red by the green and blue filters will give scarlet as magenta, will tend to make greens too yellow, and to show a slight purply shade in the blues. But this latter defect is neither as dangerous or as difficult to avoid.

First Black Condition.

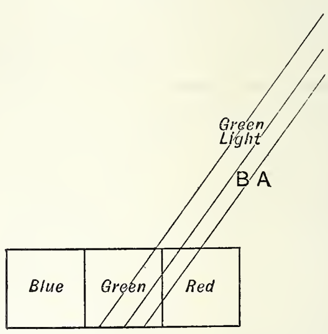
This is the title I have given to that condition to be fulfilled in the manufacture of a screen plate, which states that the screen plate when looked at as a whole must be grey or black, and not coloured in any way whatever. Of the screen plates I have seen, the one which best fills this condition is the Krayn plate, which is very slightly green; the Warner-Powrie plates are violet, and the Lumière autochrome plate is very good indeed in this as in everything else, and is faintly pink. Unless this condition is fulfilled it is not possible for whites to be neutral tinted; hence its importance. The whole picture will have a veil of the colour of the screen plate itself. The grey is, of course, produced by the accurate adaptation of the colours of the areas of the differently coloured filters. In order to obtain with the autochrome plate, for instance, the requisite grey, it has been necessary for the green particles to be 40 per cent. of the whole number.

Limiting Conditions for the Size of Screen-plate Units.

Apart from the increasing difficulties of manufacture in making plates with smaller units, there are two conditions which limit the size of screen-plate units. The first is the thickness of the dye substance itself; if this is equal to the diameter of one unit or to the width of one line, then any ray entering the screen plate at an angle above 10 degrees will be subject to considerable error, due to its parallax, it having passed not only through the unit through which it was intended to pass, but also diagonally through a portion of the adjacent unit before passing into its proper unit; so that a green ray for instance would pass through the top surface of a red unit and suffer considerable absorption before passing through the green unit itself; thus in Fig. 1, the green rays A and B are absorbed more or less completely by the red unit before passing through the green.

This condition is a serious limitation in practice; the Krayn plate, for instance, is at present made with lines about 170 to the inch, and of square section; if the lines are to be made 340 to the inch, then there can be only half the thickness of celluloid to hold the dye, which means that the dye concentration in the celluloid must be twice as great. When one

Fig. 1.



reaches fine lines in gelatine, it is of great importance; for plain gelatine coating it is difficult to get a sufficiently deep screen with less gelatine than 1 cubic centimetre of a 5 per cent. solution upon 20 square centimetres, consequently the thickness of this coating wet is one-half millimetre; when dry, it will be 1/40 of a millimetre, which gives us 40 lines of square section to one millimetre, as our limiting fineness of lines, 1000 to the inch.

The second limiting condition, which is of considerably less importance, is that imposed by the grain of the emulsion. The unit of development in a plate is a particle of silver bromide, and if any portion of a particle is exposed the whole particle becomes developable, so that if a grain of silver bromide lying almost entirely under a red unit had a small projection under a green unit, then on exposure to green light the projection would be affected, and the whole of the grain would develop, thus recording the green light as red. The diameter of the average grain of a plate can be taken as 1/1000 of a millimetre, so that there would be 25 grains in the width of a line in a

1,000-line screen. The limit so fixed is obviously that of a very fine screen indeed.

As a matter of fact, a screen of regular distribution becomes invisible to the eye at about 600 units to the linear inch; and a screen such as the Lumière autochrome, having units 1-2000 inch in diameter, would be absolutely grainless if it were not for the agglomerations of units which the screen frequently displays.

It is possible that a third limiting condition to the size of units may be found in the optical character of the screen unit itself. It has been stated that it is necessary that the refractive index of the sensitised film should be the same as that of the screen plate unit. Of this statement there has been no published proof, and it is difficult to see what effect alteration of the refractive index at the boundary between the unit and the film would have on the resultant plate, other than possibly an extremely slight loss of definition. It is, of course, necessary that with very small units the sensitive film should be in intimate optical contact with the screen. If the emulsion film be stripped from an exposed and developed Lumière plate, and again placed into contact with the screen plate, it is not merely impossible to get correct colour rendering, but it is almost impossible to get any colouring at all, owing to the difficulty of getting sufficiently good contact. This limiting condition could no doubt be worked out with regard to size of unit and difference of refractive index, and would justify the necessary expenditure of time.

Sensitising Conditions.

The conditions for making the emulsion for a screen plate are of interest. The emulsion must, of course, be of reasonably fine grain; but there seems no particular difficulty with regard to this. It is not true, as a general rule, that a fine-grained emulsion must be slow. It is quite true that a grainless emulsion must be exceedingly slow; but the variation in size of grain between a plate of speed—say 10, and say 150—is generally less than the variation which can be obtained by other alterations in emulsion making. The emulsion must be sensitised as far as possible to the whole spectrum. This can be attained to some extent by the addition of dyes, but probably fast screen plates in the future will be sensitised by bathing, that is, by immersing the plates, after coating, in a solution containing the sensitising dye. This bath can be adjusted to give either a maximum of red sensitiveness, or a maximum of green sensitiveness, or any ratio between the two. The sensitising condition to be fulfilled is that the bath should be so adjusted to the filters that the deposit beneath the red and green filters is equal in intensity. In the case of a bathed plate, with a properly adjusted bath, the blue filter will give nearly the same deposit as the red and green, and the introduction of a little black into the blue filter would probably eliminate the necessity of any further correction.

Unfortunately, however, it is not usually possible to attain always the same result in sensitising by bathing, or, for that matter, by sensitising in any other way, with sufficient accuracy to render it advisable to dispose altogether of a possible means of correcting later, so that probably it is better to allow the blue to exert rather more influence than it should, and to use a light yellow screen on the lens, or a compensator, as it is generally called, to reduce the blue to equality with the red and green; this will produce, if greys are photographed, greys on the plate, and it is easy to see whether the correction is complete by photographing a scale of greys, when any colouration will indicate bad correction.

This condition I should call the second black condition.

If the filters are of such a type that they transmit the extreme red through the green and blue filters, then it may be advisable to omit to sensitise for that region of the spectrum. If this is done, however, there will occasionally be difficulty in rendering pure deep reds, which may not record at all.

The Lumière autochrome plate appears to have been sensitised with some form of emulsion which gives curves which can only be compared to those given by collodion emulsion, the sensitising dye being an isocyanin, possibly, from the curve, orthochrome T. Like collodion emulsion, the colour sensitiveness is very considerable, and the gap in the blue-green is very much more marked than would be the case if the same dye were put into gelatine. The sensitiveness of an autochrome emulsion exposed in the sector wheel with the film side to the light, so that the sensitiveness is not measured through the screen, is 40 Watkins, this speed being then diminished by the screen and compensator to about 1 Watkins, and the density giving power is very low, density being obtained by intensification. The reason for this low density giving power is, of course, the thinness of coating which is necessary for reversal. If a screen-plate be coated with an emulsion of about 240 Watkins, which

is sensitised by bathing, so that the multiplying factor of the screen itself is 20, and a compensator requiring twice the exposure is used, then we shall get a final effective sensitiveness of 6, which is about the limit of speed which can be obtained in a screen plate, unless new discoveries are made in emulsion making.

Production of Positives.

Inasmuch as the developed screen plate renders all objects in their complementary colours, it is necessary that the plates should be in some way transformed into a positive. The method adopted by Messrs. Lumière is to dissolve out the developed silver by the aid of a powerful oxidising solvent, which in their case is an acid solution of potassium permanganate; after solution of the silver, the silver bromide which has not been developed is blackened by the application of a developer after exposure to light, and a positive results.

In order that this method shall be successful, it is necessary that under the heaviest deposit of silver in the original negative there shall be no silver bromide; that is to say, that the sensitive film shall have been exposed and developed through to the back, which is only possible with a very thin film. Ordinary thickly coated plates cannot be reversed by this method. The necessity of using a very thin film carries with it a serious restriction as to the latitude which that film will have, because very thin films will not render great contrasts of light and shade, so that this in itself is an objection to the reversing method.

Another method of reversal, which was first suggested by Major-General Waterhouse, is development with a developer containing thiocarbamide, or one of its derivatives. General Waterhouse suggested finally, tetrathiocarbamide ammonium bromide used in a developer of eikonogen and lithium carbonate. This gives a very good reversal of a warm brown colour, with only slight fog on the high lights, which can then be cleared by the use of the copper bromide reducer, the reducer changing the warm brown to a distinctly colder shade. Unfortunately, its action appears to be uncertain, and in the large number of trials I have made with it I am bound to say that I have had more failures than successes; moreover, I did not succeed in getting the final tone of my image to a satisfactory black. It is possible, however, that further work would remedy this matter, and make it possible to use thick films and a directly reversing developer.

An obvious method of using screen plates is to make a complementary negative, and then, on a plate of the same pattern to print a positive through the second screen. If this is done, however, it will be found that the colours are quite faint, being degraded by greys. The reason for this is as follows:—

Consider the colour-negative having lines of red, green, and blue, and imagine this to have been exposed to green light and developed, so that the green stripe is black; now print on a similar film put over it at right angles, and

Fig. 2.

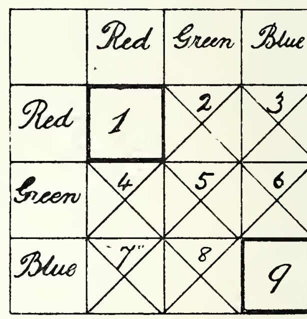
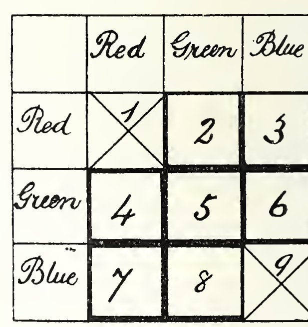


Fig. 3.



consider the nine squares thus formed, first with regard to the negative, and then to the positive produced upon development. (Figs. 2 and 3.)

Square 1 is formed by the crossing of red on red, and will be transparent in the negative, forming a black in the positive.

Square 2 red on green, is black in the negative, and transparent in the positive.

Square 3 is red on blue, black in the negative, transparent in the positive.

Squares 4, 5 and 6 have the silver deposit on them, and give transparent squares in the positive.

Square 7 is blue on red, black in the negative, and transparent in the positive.

Square 8 is blue on green, black in the negative, and transparent in the positive.

Square 9 is blue on blue, is transparent in the negative, and black in the positive. So that of our nine squares in the positive, seven are transparent, and instead of having only green, we have to three greens, two reds and two blues, thus producing always fainter colours degraded with greys.

This result is easily confirmed by direct experiment, and however the squares be arranged, whether in lines or patterns of any particular shape, it must always happen that to three greens there will be two reds and two blues, or to one square of pure colour there will be six squares making two whites.

This difficulty has been overcome by Powrie, by taking advantage of the fact that his screen is a line-screen of great fineness. He prints on a similar plate with the lines running at right angles to the first lines, but after making his first exposure he turns the printing frame through a slight angle so that the image of a line is projected not on to the top of the first exposure, but adjacent to it. He then turns the frame through a slight angle in the opposite direction, so that again the line is projected on the other side of its original image. Each line is in this way broken up into three lines overlapping its neighbours on the two sides, the effect of which is to remove the white in the print, producing a correctly coloured positive. Thus, Fig. 4 shows the printing directly through the line, Fig. 5 the printing after inclination to one side, and Fig. 6 the printing after inclination to the other side—the total result being the closed print, as is shown in Fig. 6.

If autochrome plates are made as complementary negatives and then printed as positives, the diffusion which they undergo in consequence of the small size of the starch grain and the thickness of the glass, is sufficient to give a very fairly satisfactory result. The positive print from a complementary negative, however, is slightly inferior to a direct reversed positive, as has been shown by the trials of Mr. Welborne Piper.

Powrie's method of angling in order to analyse his screen can be used in the same way as Brasseur dissects his three line positive to form a complete set of positives, each one representing one colour impression. The red line, for instance, is picked out by the use of a monochromatic red filter, the plate is exposed with a sheet of glass between its surface and that of a panchromatic positive plate in contact with it. The first exposure is made direct, the second with an angle movement which will throw the same line by the side of the first exposure, and a third with an angle movement in an opposite direction with the line on the other side, thus filling up the whole surface of the plate and producing positives in which no trace of the screen can be discerned. These plates can then be used for the production of half-tone blocks. Satisfactory half-tone blocks can be prepared from autochrome plates dissected in the same manner.

Fig. 4.

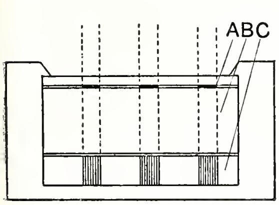


Fig. 5.

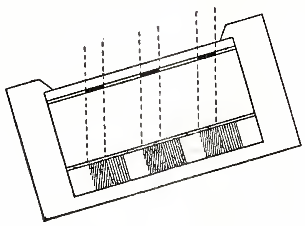
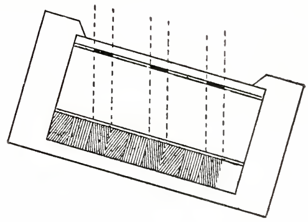


Fig. 6.



With regard to the whole use of screen plates, one is bound to feel that, interesting as they are, and marvellous as has been the ingenuity shown in the production of the Autochrome plates, yet at present their application must be limited. No colour process which cannot be printed on paper can hope to appeal to the great mass of workers, and if the plates are used as transparencies, either in the hand or in the lantern, the density caused by the presence of the screen is so great that special viewing apparatus is desirable, a very great drawback indeed to the plates. What screen plates need, in fact, as their complement is a printing process such as a somewhat improved bleach-out emulsion which can be placed on paper, and on which the plates can be printed by an angling movement (for which reason one feels that line plates are those with the greatest future), or which can be placed on glass, thus forming whole-tone positives without the light-absorbing colour screen darkening the whole picture.

In the meantime, screen plates, and espe-

cially that which alone can be obtained at the present time, the autochrome plate, must surely form the most fascinating toys as well as the most useful instruments which photography has to offer.

DISCUSSION.

The CHAIRMAN (Professor Trouton), in opening the discussion, said he would like to ask the author, from his experience, whether in regard to the point that had been neglected in the Lumière process, namely, the possibility of getting correct representation of colour, it was impossible to obtain correct representation of colour with the use of a single partly coloured screen, used both for preparing a negative, and for viewing the positive obtained from it. The reason for this was obvious. If one took the spectrum, in order to have a correct colour to view the spectrum with, the red must be the extreme red of the spectrum. That being the case, it made it impossible to get the yellow part of the spectrum, because here we wanted the red line to transmit green also, so that if one had, as the red colour the necessary colour for viewing the photograph, viz., extreme red, then that screen was erroneous when taking the yellow. A compromise had to be made if one screen was used. Dr. Joly, who worked at the subject for a number of years, was using at first the process that Lumière had brought to such perfection, and he (the Chairman) had always thought it a pity that Joly did not continue with it. Joly had been deterred from going on with the process, owing to its scientific inaccuracy. That he thought was a great pity, because people were not so particular about colours as all that. Two pictures of the same colouration by two artists would be quite different in tone, and people were from infancy accustomed or educated up to being content with what were really erroneous representations of colour provided they were harmonious, and he thought that the fact of Joly having dropped Lumière's process owing to its scientific inaccuracy was a pity.

Sir RAY LANKESTER, K.C.B., F.R.S., was extremely interested in the process from the point of view of scientific records. He had been much interested in what the author of the paper had said as to the accuracy of the registration of colour. Photography, to many scientific people, was a means of registering form. With proper focal distance, one could depend on a camera to give accurate records of form of any kind, and he had been in hopes that the colour-screen system would have enabled photographers to register colours in the same correct way. He was, however, a little shocked to hear the author speak in such a very light way of the inaccuracy in photographing colour, as though it did not matter. For the purposes of recording natural history objects of different kinds, colour photography was very important, and it would be a most delightful thing if a colour process were developed which would enable one to register a thing in its true colours straight away. He himself, with the help of a professional photographer, had tried with the Lumière process, whilst he was still Director of the Natural History Museum, by photographing some eggs, containing amongst them a cuckoo's egg. In that case it would have been interesting if one could have obtained an accurate record of the colour of the cuckoo's egg, and other eggs associated with it, to show the degree to which the parasitic bird's egg approached the colour of the egg of the bird on which it was parasitic. He had also tried to photograph some iridescent shells and some very brilliantly coloured birds. The former photographs turned out well, but with regard to the delicate shades of birds' eggs he was not so well satisfied. Another thing which he found was that the Lumière plates, as supplied to him, were spotted all over. He did not know whether they were faulty and should have been returned to the makers or not, but they spoiled the effect of many photographs which he had had taken.

Mr. HOWARD FARMER observed that perhaps the most important point which had been raised by the author was that the colours of the taking-screen should be different from those of the projecting. He would like to ask if the author could give any reference which showed that to be the fact.

Mr. CHILD BAYLEY said the author had not fully dealt with what he (the speaker) considered to be one of the most important observations in the paper, namely, the question of parallax. The author had said that a ray falling at an angle of more than 10 degrees to the normal would give incorrect colours. If that were so, it would be found by using a photographic lens, including an angle of, say 80 degrees, that the colour would be incorrect towards the edges of the plate. He himself had noticed that to be so on many autochrome plates which he had seen, and he had seen plenty.

Dr. C. E. KENNETH MEES, in reply, said that the Chairman's and Mr. Farmer's enquiries dealt with this point that the viewing and taking-screen should not be identical. He had no intention of arguing out the question with Mr. Farmer. It was an old argument, and authority was on his side, though he was not prepared offhand to substantiate this statement by references. It was his impression that the taking filter ought to be different to the viewing filter; he might be wrong, he did not know. The

Chairman seemed to concur with him that the filters should be different, and he thought that that was also Professor Joly's view of the subject. There were also a great many other people who held the same opinion. Some colours could not be reproduced by any screen process, *e.g.*, spectrum red, but spectrum red was an exceedingly rare colour in nature. There were a few things which were a deep spectrum red in colour, but they were nearly always found to be aniline dyes, so that on the subject of aniline dyes one might not be able to render. The spectrum could not be rendered, but mixed colours were, he thought, very well reproduced. With regard to Prof. Lankester's point, in most cases he should say that the Lumière plates would be very useful for colour reproduction, but not, unfortunately, for spectrum work, and the same was the case with any other plate of the type. It was rather unfortunate, because it would be very convenient to be able to project spectra in natural colours by preparing lantern slides of them. As to the accuracy of the reproduced colours, it seemed to him that depended on the operator, who might repeat his attempts, and if he could not produce sufficiently accurate results, then the attempt was a failure, and must be given up. The number of times, however, that an operator would fail would, he thought, be rare; it depended, of course, on the accuracy which was required. With reference to spots, they were old friends of his. Every plate-maker knew about ten forms of spots, not only in regard to the Lumière plate, but in all other plates. He imagined, however, that the difficulty was merely a manufacturing detail, which would be rapidly overcome, if it had not been done so already. Some of the earlier Lumière plates had frilled, but later ones had not. When a process was in its infancy there were many difficulties to be overcome. The difficulties in regard to the preparation of starch grain plates, for instance, must have been colossal.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Dr. Mees for his paper, and the meeting terminated.

FRUIT GROWING IN BRAZIL.

The question of fruit growing is now attracting considerable attention in Brazil, and in the State of Sao Paulo active measures are being taken for the development of the fruit industry. An expert appointed by the Government has been sent to Italy to make certain investigations in fruit culture, and also to arrange for transporting to southern Sao Paulo one hundred families of Sicilian viticulturists and fruit growers. It is the intention of the Department of Agriculture to secure, for purposes of experiment, a concession of Government land upon which these immigrant fruit growers are to be established. Later, a co-operative society is to be organised which will purchase the output of the fruit farms for vintage purposes. The activity of the Department of Agriculture in seeking to develop various industries within the State is attracting more than ordinary attention on the part of intelligent planters and farmers. Large areas in Sao Paulo are as well adapted to fruit growing as many parts of southern Europe, and with proper attention this branch of agriculture should be made to yield a large income. This, says the American Consul-General at Rio de Janeiro, is also true of Santa Catharina, Rio Grande do Sul, and many parts of Parana. In the former State, grape culture has been developed to an important industry, as was evidenced by the recent exhibition in Rio by the State Government of a large variety of wines produced from Rio Grande grapes. The exhibit also embraced canned and preserved fruit products. Those put up in tins were attractively labelled and presented a good appearance. Some of the better descriptions of preserves were put up in neat glass bottles. All of these products are on sale in Rio de Janeiro, and are finding a ready market, inasmuch as the prices asked for them range much below those of imported articles. Fruits other than grapes are being cultivated in Rio Grande do Sul, with marked success. Peaches are probably the most important of these, great quantities of which are dried and packed for shipment to all parts of Brazil. The method of preparation of this fruit is such that its appearance is similar to the cheaper kinds of dried apples packed in the United States. While apple production is yet small, some excellent qualities are being grown, and small shipments are sent to the various coast cities of Brazil. Figs are grown in small quantities and find a market in other parts of Brazil, mainly in the form of canned preserves. One great drawback to the development of the fruit industry in southern Brazil is the difficulty attendant upon the marketing of the fresh fruit, due to the inadequacy of transportation facilities and to the custom of the Brazilian merchants, who wish to sell few goods at enormous prices rather than in large quantities at small profit. During the grape season in Rio Grande do Sul, good black grapes sell for a little more than one half-penny a pound. The cost of transporting them to Porto Alegre or to Rio Grande do Sul brings the price up to about two pence per pound, while in Rio de Janeiro, grapes which sell in the interior of Rio Grande do Sul for one half-penny a pound fetch from ten pence to a shilling. In Santa Catharina, although the conditions are favourable for the cultivation of a great variety of fruits, the banana receives the most attention. Nearly all of Brazil is within the banana belt, but in Santa Catharina only is the general cultivation of this fruit carried on extensively. Most of the bananas produced are shipped south to the River Plate ports, the Brazilian ports to the north

being supplied by the numerous varieties of banana trees which grow in a more or less wild and uncultivated state over many portions of central and northern Brazil. The departments of agriculture in Rio de Janeiro and Minas Geraes are evidencing considerable interest in the culture of fruit, and although the results are as yet meagre, they are conclusive in demonstrating that many fruits common in more temperate climates may be cultivated with profit on the uplands of these States. In all of central and northern Brazil, the orange grows so generally in an uncultivated condition that a large share of the supply comes from that source, but the importance of careful nurture has begun to receive general recognition, and in Sao Paulo, Minas Geraes, and Rio de Janeiro, a great many coffee planters have a cultivated orange orchard. Here again the difficulty of costly transportation presents itself. The high-class fruit which can be produced in the interior cannot compete with the inferior qualities growing wild in the rough, untilled lands near the coast, and therefore near the market. Probably the best oranges of Brazil are grown in Bahia and Pernambuco, and large shipments from there come to the southern ports of the sea-board, but freight charges are high. Undoubtedly a great stimulus would be given to fruit growing by the establishment of cold storage facilities in the larger cities, and in connection with transportation. A refrigerator car is unknown in Brazil, and can scarcely be introduced while ice-making is carried on to so limited an extent as at present. There are indications that Sao Paulo and Rio de Janeiro will soon be connected by rail with Rio Grande do Sul, in which case competition between land and ocean routes may result in the improvement of facilities for carrying perishable goods, as well as in the reduction of rates. This would mean an added impetus to all agricultural pursuits, but especially so in the case of fruit growing, since the important fruit country in the south would thus be placed in touch with the Sao Paulo and Rio de Janeiro markets. The movement already under way in the production of wines seems to indicate that it is possible for Brazil to become more or less independent of Europe for its wine supply. The interest taken by the agricultural departments of the various States in the establishment of model farms, with special attention to the possibilities of fruit culture, is, it is said, certain to result in the development of an extensive fruit industry in Brazil. There will then be opportunities for the establishment of canning factories on a large scale, and Brazil may become independent of Europe and the United States for her supply of canned and preserved fruits.

THE ADULTERATION OF MILK.

There is reason to fear that fraud is still prevalent in connection with the sale of milk, and how difficult it is to prevent it is shown in the annual report of proceedings under the Sale of Food and Drugs Acts, the Merchandise Marks Acts, &c., just issued. The view taken by some people of adulteration was illustrated by the evidence of witnesses in an action heard at the Hull County Court, in which one milk-seller, who had been fined for selling adulterated milk, claimed damages against another. One witness, who had seen the plaintiff add half a bucket of water to a churn of milk, averred that he did not know that the plaintiff's action was wrong. Another witness stated that he understood that "they were allowed so much water to every gallon of milk." And there seems to be some ground for the complaint from local authorities that the existing law does not give them adequate powers to prevent or punish the adulteration of milk. Thus an application for a summons was made on behalf of the St. Pancras Borough Council to meet the following facts:—An inspector, under the Sale of Food and Drugs Acts, had met a van going to the station for milk. In it were three churns which contained milk diluted with 70 per cent. of water. Questioning the carman the inspector found that the diluted milk was to be mixed with milk which was to arrive by train and then be delivered to customers. The Court, after deliberation, found it impossible to grant a summons. Cases might also be cited in which inspectors have seen milkmen add water to milk and have been unable to take any proceedings against them under these Acts.

The attitude of officers of local authorities, and also of the courts, towards cases of alleged milk adulteration appears to vary widely. In some districts, according to the report, the extent and possible causes of the variations which may occur in the composition of genuine milk are fully recognised; in others they are ignored. In some districts almost every case of alleged milk adulteration is dismissed, while in others convictions are obtained in a large proportion of such cases. Agriculturists complain that the farmer who sells milk which is genuine is unduly exposed to the risk of being charged under the same section of the Act, and made liable to the same penalties, and subjected to the same stigma as a person who is guilty of fraudulently adulterating milk or fraudulently selling adulterated milk. It is said that farmers could avoid this risk by better feeding or by getting rid of cows which yield a poor quality. But the variations in the composition of milk are generally independent of the feeding of the cows, and a cow which gives poor milk immediately after calving may be quite satisfactory later on, nor would it be practicable for a dairy farmer to be constantly drafting out of his herd all cows whose milk was temporarily of poor quality.

The warranty clauses which enable the retailer or wholesale dealer who has adulterated milk to escape conviction by producing a warranty and giving evidence that he sold the milk in the same state in which he purchased it would seem to work unsatisfactorily. They not infrequently work injustice to the farmer

whilst allowing the real culprit to escape. The adulteration of milk is generally carried out by some person through whose hands it passes after it has left the control of the farmer, and if the conscience of such person allows him to adulterate milk it will probably allow him to give evidence that he did not adulterate it. Moreover it is the practice of dealers to mix the milk of various consigners in order to make up the quantities required by different customers, and it must often be impossible for a dealer to be certain that the milk in respect of which he is summoned is really the milk sent to him by the farmer whose warranty he produces.

The report refers to the possibility of instituting a voluntary control of the milk supply on the lines of the Dutch Butter Control, a suggestion that has been seriously considered by certain local authorities. The system would be based on an arrangement by which dairymen who complied with certain conditions imposed by the local authority, with a view to ensure the delivery of milk to the consumer in a pure and clean state, would be allowed to advertise that their business was carried on under the supervision of the local authority. This proposal has the merit of being one which might be put into operation without further legislation. The prospect of success would, the department considers, depend on how far the consumers of the locality were alive to the risks of drinking contaminated milk, and desirous of obtaining clean milk.

THE CALAIS LACE TRADE.

The pre-eminence of the city of Calais as a lace centre, is chiefly due to the cleverness of its lace-makers. It should be borne in mind that a lace loom, although of the most intricate mechanism, is still only an instrument, the production from which depends entirely upon the ability and energy of its operator. Calais has a population of 70,000, about 60,000 of whom gain their existence from lace-making, and yet very large concerns do not exist there. On the contrary, there are six hundred and fifty small factories in Calais, in many of which the wife adds her intelligence to that of the husband, in making the factory a success. According to the American Consul there, machine-made lace is almost the sole industry of Calais. In Calais, there is a technical school, under the supervision of Abbé Piedfort, which has for its object the training of young boys in the methods of lace-making. This school embraces sketching designs, designing (*i.e.*, reducing the sketch to the mechanism of the loom), lace-making, and gives the necessary instruction to qualify persons to become what is known as "metteurs en œuvre" and "regleurs." The two latter are professions in the lace manufacture for which no English names have as yet been employed. The "metteurs en œuvre" and "regleurs" may be said to be the mechanical doctors of the loom. In Calais, Caudry, and St. Quentin, there are in all about one thousand and forty factories. Their many looms turn out enormous quantities of lace, which, after it is dyed, has to be clipped of its surplus threads. The output of the largest factory amounts to about £100,000 annually. It is difficult to give the output of an average factory, as they have from one to sixty looms. As to the number of inhabitants, who live wholly from the making of lace in northern France, only an estimate can be made, but the figures may be put at 100,000. The clipping of the surplus threads employs, irregularly, in the villages within fifty miles of Calais and surrounding Caudry and St. Quentin, another 100,000. Of course, as to these, no accurate statistics can be had, but anyone visiting the many villages about Calais can see everywhere in every household women and children engaged in clipping lace. In estimaaing the population engaged in, and supported by, this industry, no account is taken of the spinners of the threads used in lace-making. The spinning industry is an enormous one at Lille; many fortunes have been made there in spinning the thread for Calais, Caudry, and St. Quentin. A good deal of thread also is imported from the United Kingdom. Merchants have even in Calais grown rich in furnishing the lace manufacturers with thread. The approximate output of the lace industry in Calais, Caudry, and St. Quentin is £4,000,000. The industry in the last three years has increased more than 50 per cent. in Calais. Everywhere are to be seen proofs of this prosperity in the way of new buildings, new residences, &c.

RUSSIAN SALT LAKES.

"Limans," or salt lakes, which are situated near Odessa, are, says the United States Consul at that city, nothing more than river estuaries which have become cut off from the sea by means of a complete bar thrown across the entrance, and later on raised above the sea level. Owing to great evaporation, the originally merely brackish waters in these limans attained such high concentration that it became possible to work them for salt, which, before the discovery of the enormous rock salt deposits in South Russia, was of the greatest importance for the whole of South-West Russia. These limans, however, have other properties, imparting to them a lasting value. Numerous are the cases where persons taking the baths at the balneological institutions erected at the limans, or even simply bathing in the open air in the limans, have regained health, and have freed themselvee from various forms of gout, rheumatism, &c. This peculiar quality of the salt lakes is attributed to the slimy black ooze which forms their bottom, and consists of impalpably fine mineral matter mixed with the ultimate results of the decomposition of certain flora and fauna, apparently only present in the salt water of these lakes, but not in that of the sea.

The death of innumerable generations of these animal and vegetable organisms was occasioned by the alternate changes in the concentration of the brine, which was either rendered too fresh for them by the small rivers discharging into the lakes, bringing down an unusually large volume of fresh water, or which became too salt for any life owing to an extraordinary evaporation. Dying, they sank to the bottom, and were covered by the fine particles of mineral matter brought down by the rivers. Lying under the highly salt water of the lakes, the two constituent parts underwent that joint alteration which terminated in the formation of the black mud now constituting the bottom of the limans.

ADMIRALTY CHARTS.

The following is the official list of charts issued by the Hydrographic Department of the Admiralty, in November, 1907 :—

New Charts.—No. 3676—United States, east coast :—Fletcher's neck to Merrimac river. 3678—British Columbia :—Port Simpson. 3660—Gulf of Aden :—Aden harbour. 7—Gulf of Aden :—Aden harbour and approaches. 3666 — East coast of Korea :—Fusan harbour to Chukupen bay; Chukupen bay; Chukusan po.

Charts that have received additions or corrections too large to be conveniently inserted by hand, and in most cases other than those referred to in the Admiralty Notices to Mariners :—

No. 240—England, south coast :—Hamoase. 2682—England, west coast :—Nash point to New passage. 1538—Ireland, west coast :—Foynes harbour. 2049—Ireland, south coast :—Kinsale to Wexford. 2241—Baltic :—Entrance to Gulf of Finland and northern entrance to the Gulf of Riga. 2285—Black sea :—Varna; Baljik bay. 233—Africa, north coast :—Suez Canal. 330—North American lakes :—Lake and river St. Clair with the Detroit river. 612—North America, east coast :—Little Spoon island to Permaquid point. 2853—Gulf of Mexico :—Mississippi sound and Mobile bay. 229—United States, west coast :—Point Pinos to Bodega head. 2172—Alaska :—Bering strait. 623—Africa, west coast :—Fernando Po island. 2404—Singapore main strait from Tree island to Batam bay. 2023—Singapore :—Keppel harbour. 1199—China, east coast :—Kue shan islands to the Yang tse Kiang. 1601—China, north-east coast :—Wusung river. 3412 — Tasmania :—Hunter passage. 781—Pacific ocean :—N.W. sheet. 783 — Pacific ocean :—S.E. sheet. 2460 — Pacific ocean :—Kamchatka to Kadiak island, &c.

These charts are issued by Mr. J. D. Potter, 145, Minories.

ARTS AND CRAFTS.

Furniture.—Modern furniture-making has in England been following in the main two lines and two lines only. The greater part of the better sort of furniture which is being turned out is in imitation of some old English style, Chippendale, Sheraton, or the satin-wood variety of a still later period occasionally inlaid but more often rather elaborately, not to say heavily, painted. We have been inundated with chairs which, if not sold as Chippendale, at any rate were as exact a copy of old work as could well be made. Those of us who are not led entirely by fashion are tired by this time of table-tops decorated in the centre with the inevitable shell; but the fashion still goes on, in some quarters at least, and the craze for satin-wood furniture is by no means over. It is perhaps owing, in part at least, to the extravagance of some of the up-to-date furniture that quiet folk have gone so completely back to the old paths. Be that as it may, the furniture now being made on "modern" lines is chiefly of the cheaper and commoner sort. When we turn to drawing-room furniture, it is really difficult to believe that there has been any modern movement at all, and the more dignified type of dining-room and bedroom furniture, though it is not exactly like what such furniture would have been say, fifteen years ago, has nevertheless fallen back into something not altogether unlike the old accustomed rut. This fact, though it is, in a sense, to be regretted, does not, in view of some of the extravagances into which, at one time at least, it bid fair to wander, leave us altogether inconsolable.

When we think, therefore, of the rather tame reproductions of old and of the rather mannered modern trade work, we are inclined to say that modern furniture, in England at least, is hopelessly dull, that it generally follows the beaten track too closely to allow of much originality, and that when it gets away from the ordinary and strikes out into originality, its ingenuity is rather to seek. It seems to avoid what has been done more because it has been done than because its makers have ideas of their own on the subject of furniture design, or principles which guide them. At one time, in London at least, and presumably elsewhere, we used to see from time to time examples of simple furniture sometimes rather clumsy, but still constructed on workmanlike lines, and satisfactory enough in their way; but of late there has been very little interesting furniture exhibited, and it has been really refreshing to come upon the little show of Mr. Gimson's work at Debenham and Freebody's. Some of us remember the time, not so very long ago, when Mr. Gimson began to exhibit very simple wooden chairs at the Arts and Crafts. He still produces chairs of somewhat the same type, and the large bowed sideboard which makes part of the London show, though it might fit well enough in its right place, does certainly look rather cumbersome. This same oak sideboard, though, is an admirable

example of the satisfactory use of gouge work in the decoration of simple furniture. The greater part of the exhibition, however, consists of work which could by no means be called clumsy or cumbersome. Mr. Gimson has gone on the plan of making his work as simple as possible. He avoids mouldings and all architectural trimmings, and makes no neat little ledges specially adapted to collect the dust. His forms are restrained and workmanlike—he is content to make something which, while admirable in proportion and construction, is simple and quite unobtrusively distinguished. His feeling for his material is shown not only in the technique of his workmanship—the doors hang perfectly, and the drawers run so smoothly, that it is quite a pleasure to pull them out and push them in again—but also in the way in which he chooses his woods. The panels are, so far as possible, arranged to show the markings of the wood to advantage, and in the cases where a piece which differs slightly in colour from its surrounding has to be worked in, care is taken to place it in such a way that it helps, instead of marring the general effect. Great attention, too, has been paid to the handles. In the heavier cupboards and chests of drawers, wooden handles are used which are practical, besides being very firmly attached, and the metal fittings of the cabinets and smaller cupboards are worthy of the furniture on which they find themselves. The only discordant note is the occasional ugliness of the keys which, even when they have been chiselled a little, have a way of looking rather common. Mr. Gimson shows a fair amount of inlay, relying indeed almost entirely upon it for his decoration. Some of this is quite simple work, such as we have seen for some time past in the better class shops, but some of it comes into quite a different category. There are one or two examples of cabinets of which the fronts are inlaid with foliated pattern, the wood for which is so cunningly picked that the grain gives the effect of the veins of the leaves. Yet other objects are inlaid with patterns in mother-of-pearl and silver, or with mother-of-pearl alone, and with very happy results. In almost every case the material has been chosen and arranged so as to show to the greatest advantage; moreover a convex surface has been given to the piece of furniture, and sometimes also to the inlaid material, so as to lose none of the value which is to be had from the play of the light. It is refreshing to see a collection of furniture so pleasing, so modest, so well-made, and yet possessed of so much quiet dignity and with such a well-marked character of its own. The work is never aggressively original, but it leaves the impression of being, in its quiet way, quite unlike what one has been in the habit of seeing.

Wood-carving.—Another inspiriting little exhibition of woodwork was that held at the School of Art Wood-carving just before Christmas. The show was of a modest kind—just made up of the ordinary work done by the students in their school course. There was, perhaps, nothing which was individually very striking, nothing very remarkable or very original but there was evidence, and abundant evidence, of good, sober, solid work. One has begun to suspect that a school which tacks the word "art" on to its title may very likely be a place where defective craftsmanship hides itself under the mantle of art—an art itself, perhaps, none too genuine—but the School of Art Wood-carving proves by such shows as this, its right to rank as a school of craftsmanship in the best sense of the term. The students are not encouraged to imagine that they can learn their craft in a few lessons; they are expected to work steadily at their trade in the school and for some time longer in the workshop before they can consider themselves accomplished carvers. They are not taught to look upon themselves as artists who condescend to craftsmanship, but primarily as workmen whose trade demands of them a certain knowledge of drawing and of the first principles of art. If they develop into artists so much the better, but there is no reason to imagine that they inevitably will.

That the teaching they get in the school is of a kind to turn out competent carvers is shown by the works exhibited—which were grouped so as to show the work done by the students in their first, second and third years respectively, an arrangement which made it comparatively easy to see the course of study pursued and the stages through which the students pass. One has heard trade carvers speak disparagingly of the school. If they would but pay it a visit they would alter their tone.

Embroidery and Hand-loom Weaving. — Embroidery and hand-loom weaving have been represented at several little shows within the last few weeks. Miss Garnett's little exhibition at the Lyceum Club was a veritable feast of colour, and proves conclusively that, under competent guidance very satisfactory work can be turned out by north country peasant women. The hand-woven silks were fine in texture and beautiful in colour, and though too expensive for a good many purses, they were not dear considering their quality. The embroideries were harmonious in tone and quite excellently worked.

The Home Arts and Industries tried the experiment of having a Christmas sale in Bond-street. The work was of various kinds, but some of the most interesting exhibits consisted mainly of weaving, rug-making, and embroidery. Unfortunately, want of space made it difficult to see the works to advantage.

It was rather disappointing not to see more needlework in the exhibition of the work of Birmingham artists and craftsmen held at the Fine Arts. Those who care for needlework have learnt to expect a good deal from Birmingham, and it was a pity not to have the chance of seeing more. What was shown, however, was altogether pleasing, though some of it seemed strangely familiar. The most striking feature of the embroidery was perhaps the little collection of Mrs. Southall's admirable cutwork.

GENERAL NOTES.

Exhibition of the Orient in London.—Under the auspices of the London Missionary Society, a great Missionary Exhibition is to be held at the Agricultural Hall from June 11th to July 11th next. The loan of specimens of every description of missionary interest is asked for, such as idols, weapons, and any other article which will help to make those who visit the Exhibition somewhat more acquainted with the daily lives of the people in foreign lands, and which will instruct them in the industries, pastimes, and idolatrous practices which occur there. These are required, more particularly from India, China, Africa, South Seas, Somoa, and New Guinea. Insurance against fire and burglary will be effected, and all exhibits will be returned as soon as possible after the close of the Exhibition. Those who are willing to assist, by the loan of objects for the Exhibition, should communicate with Mr. A. J. Parnell, Exhibit Secretary, "Denham," Beech-house-road, Croydon.

The Amsterdam Diamond Trade.—In the course of his report on the trade of Amsterdam (Cd. 3727-31), Mr. Consul Churchill refers to the diamond industry. He says that last year showed progress in it. During the greater part of the year there was an active demand for polishing. The chief point was the universal demand for small work, which caused prices to increase. The fashion of diamond jewellery is set in Paris, and the designs required small work, which is a speciality of Amsterdam workers. The exports to the United States amounted to about £2,400,000, or £400,000 more than during the preceding year. The exports to other countries are not stated. Amsterdam employs 9,275 diamond workers, and the amount of wages paid in one year amount to as much as £1,680,000. Three new factories were built during last year, one of which, a model establishment, with 300 mills, cost about £41,000.

Cigarettes in China.—The enormous and rapidly increasing demand for cigarettes in China is shown by figures given by Sir Alexander Hosie in his report on the foreign trade of China (Cd. 3727-26). The value of imported cigarettes rose from £658,250 in 1905 to £962,282 last year. Of the gross import in 1905 about 50 per cent. came from the United States, over 21 per cent. from the United Kingdom, and nearly 20 per cent. from Japan. The import does not seem to be affected by the huge output in China itself. Sir Alexander Hosie knows of seventeen cigarette factories in China (there may be more) the largest of which, the property of the British Cigarette Company in Shanghai, is equipped with both British and American machinery, has a staff of some 33 foreigners (British and American), and turns out 8,000,000 cigarettes a day. The same company has recently erected a factory at Hankow capable of a similar output. Many of the factories are small concerns, but the Shanghai company employs in addition to the foreigners referred to above, a large number of travelling agents in the interior, and gives employment to about 2,500 Chinese men, women, and children of both sexes.

Australian Government Offices in the Strand.—In the course of his budget statement, an official copy of which has been sent to the *Journal*, the Treasurer of Victoria, the Honourable Thomas Bent, referred to the decision of his Government to take a lease of a site in the Strand, upon which to erect an office for the Agent-General of Victoria, wherein a proper and effective display of Victorian products can be made. When in London, Mr. Bent came to the conclusion that the site in the Strand which has now been selected is the best for the purpose in the whole of London. After a good deal of negotiation with the County Council, an agreement was entered into by which Mr. Bent obtained a corner piece of land with a frontage of 25 feet to the Strand, and a depth of 65 feet alongside a 50 feet street, running through to Aldwych. The annual rent to be paid is 11s. 2¼d. per square foot, with a 99 years' lease. No rental is to be paid for the first year, one quarter the second year, a half the third year, three-fourths the fourth year, and the full rental on the fifth and the following years. This amounts to about £800 per annum. £8,000 has been provided for the building, and the interest on this amount at 4 per cent. is £320 per annum, thus making an annual outlay of about £1,120. The rental of the Agent-General's present office is £700 a year.

Government and Municipal Enterprise in Bulgaria.—Strenuous efforts are being made by the Bulgarian Government to promote the industrial, commercial, and agricultural welfare of the principality. Besides the law for the encouragement of native industries, and the law regulating the hours of labour of women and children in factories and workshops, and various other measures dealing with the appointment of a large number of factory and agricultaral inspectors, the insurance of workmen, and the penalty to be inflicted on those attempting to create strikes, considerable sums have been voted for the construction of new roads throughout the country, and for the repair of those already in existence. In his report on the trade of Bulgaria just issued (Cd. 3727-32), Mr. Vice-Consul Toulmin refers to practical courses in tailoring, boot and shoe making, weaving, masonry, pottery, &c., as having been instituted under the supervision of the Chambers of Commerce. Agricultural schools too, with model farms attached, have been established, where instruction is given in viticulture, agriculture, fruit and silk growing, and poultry-rearing, and the State Agricultural Bank sells to the peasantry oxen, seeds, agricultural machinery and implements at cost price, and accords them long terms of credit for repayment. Bulgaria seems to be moving with the times.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

January 22.—"Siam and its People." By Harry Hillman.

January 29.—"The New Patent Act." By John William Gordon. Sir William Preece, K.C.B., F.R.S., Vice-President of the Society, will preside.

February 5.—"War Balloons." By Auguste E. Gaudron. The Hon. Charles Rolls will preside.

February 12.—"The Application of Science to Foundry Work." By R. Buchanan, President Staffordshire Iron and Steel Institute.

February 19.—

February 26.—"The Problem of Road Construction, with a View to Present and Future Requirements." By H. S. Hele-Shaw, LL.D., F.R.S., and Douglas Mackenzie.

Dates to be hereafter announced :—

"Recent Improvements in Decorators' Materials." By A. S. Jennings.

"The Underground Water Supplies of the Thames Basin." By Clayton Beadle.

"Industrial Entomology: the Economic Importance of a Study of Insect Life." By F. Martin Duncan.

"Modern Dairy Practice." By Loudon M. Douglas.

"The Law of Treasure Trove." By William Martin, M.A., LL.D.

"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By Ernest R. Matthews, F.R.S.E., Assoc.M.Inst. C.E.

"The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds." By Lovell N. Reddie.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

February 13.—"The New 'Imperial Gazetteer of India.'" By Richard Burn, I.C.S. (To be read by William Foster.)

March 12.—"Progress of Native States during the past Forty Years." By Sir David W. K. Barr, K.C.S.I., Vice-President of the Council of India.

April 30.—"Reminiscences of Indian Life." By the Right Hon. Lord Lamington, G.C.M.G., G.C.I.E., late Governor of Bombay.

May 21.—"The United Provinces of Agra and Oudh." By Sir James John Digges La Touche, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

January 28.—"The Development of Colonial Self-Government in the Nineteenth Century." By A. Berriedale Keith, M.A., B.C.L., M.R.A.S. The Right Hon. Sir Charles Wentworth Dilke, Bart., M.P., will preside.

February 25.—"Irrigation in Egypt under British Direction." By Sir Hanbury Brown, K.C.M.G. The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., will preside.

March 24.—"The Mineral Resources of Western Australia." By the Hon. C. H. Rason, Agent-General for Western Australia.

April 7.—"The Imperial Problem of Asiatic Immigration." By Richard Jebb.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

January 21.—"Developments in the Art of Jewellery." By Mrs. Hadaway. Henry Hardinge Cunynghame, C.B., will preside.

February 18.—"Banners in Pageantry." By George W. Eve. Walter Crane, R.W.S., will preside.

March 31.—"Enamel Portraits." By Cyril Davenport, F.S.A. Sir Hubert von Herkomer, C.V.O., R.A., will preside.

April 28.—"Lace as a Modern Industry." By Miss Isemonger.

May 26.—

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Henry Hardinge Cunynghame, C.B., "The Theory and Practice of Clock Making." Six Lectures.

Lecture I.—January 20.—The history of clocks—The verge escapement—Invention of the pendulum—Its adaptation to clocks—The anchor escapement—The dead-beat escapement—Attempts at detached escapements—The gravity escapement—Remontoirs—Detached gravity escapements—Electric clocks.

Lecture II.—January 27.—The theory of the pendulum—The simple pendulum—Motion of a particle under an accelerating force—Motions upon a curve—The cycloid—Motions in a circular arc.

Lecture III.—February 3.—The simple pendulum concluded—The compound pendulum—General formula—Moment of inertia—Corrections for circular error, and for moment of inertia of bob—Air buoyancy, its effect on pendulums.

Lecture IV.—February 10.—Method of compensating pendulums for the expansion of the rod, the bob, and the temperature of the air—Barometric correction—Method of construction of pendulum—The gridiron, the mercury, the zinc and steel, lever and other pendulums.

LECTURE V.—FEBRUARY 17.—The pendulum continued—Modes of suspension—Air-tight cases—The escapement—Principle of the escapement; effect of disturbances—The dead-beat escapement—Detached escapements and gravity escapements—The escapements of Mudge, Cummings, Bloxam, and Denison.

LECTURE VI.—FEBRUARY 24.—The theory of escapements concluded—Teeth of wheels—The theory of epicycloidal teeth — Involute teeth — Lantern pinions—Electric clocks—Main divisions of electric clocks—Difficulties to be contended with—The clock of the future.

PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." Four Lectures.

March 9, 16, 23, 30.

WILLIAM BURTON, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.

May 4, 11, 18.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

FEBRUARY 7.—"The Hygiene of the Pottery Trade." By WILLIAM BURTON, F.C.S., Chairman of the Joint Committee of Pottery Manufacturers of Great Britain.

FEBRUARY 28.—"The Removal of Dust and Fumes in Factories." By JOHN SCOTT HALDANE, M.A., M.D., M.R.C.P. (Edin.), F.R.S.

MAY 15.—"The Dangers of Coal Dust and their Prevention." By W. E. GARFORTH, President of the Colliery Proprietors' Association of Great Britain.

Date not fixed :—

"Child Workers and Wage Earners." By MISS NETTIE ADLER, Hon. Secretary to the Committee on Wage Earning Children.

HOWARD LECTURES.

Thursday evenings, at 8 o'clock :—

H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

March 19, 26, April 2.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 20...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. H. H. Cunynghame, "The Theory and Practice of Clock Making." (Lecture I.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. T. Oldrieve, "Royal Palaces in Scotland."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Colonel T. H. Hendley, "Resemblances between Jewish Ideas and Customs and those of India."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. L. E. Hill, "Researches on Deep Sea Diving."

TUESDAY, JAN. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mrs. Hadaway, "Developments in the Art of Jewellery."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. A. Gray, "The Internal Ear of Different Animals." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Sir John W. Ottley and Dr. Arthur W. Brightmore, "Experimental Investigations of the Stresses in Masonry Dams subjected to Water Pressure." 2. Messrs. John S. Wilsou and William Gore, "Stresses in Dams: an Experimental Investigation by means of India-rubber Models." 3. Mr. Ernest Prescot Hill, "Stresses in Masonry Dams."

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Mr. Reginald Dudfield, "Some Unconsidered Factors Affecting the Birth-rate."

WEDNESDAY, JAN. 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Harry Hillman, "Siam and its People."

Geological, Burlington-house, W., 8 p.m.

Auctioneers' Institute, 34, Russell-square, W.C., 7½ p.m. Mr. J. Otway Cavey, "Auctioneers' Accounts and Bookkeeping."

Royal Society of Literature, 20, Hanover-square, W., 8½ p.m. Professor J. B. Mayor, "Tolstoi and Shakespeare."

THURSDAY, JAN. 23...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institute, Finsbury-circus, E.C., 6 p.m. Mr. C. J. Tabor, "The Furniture of an English House a Century Ago."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. W. Watts, "Recent Light on Ancient Physiographies."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Rudolph Goldschmidt, "Standard Performances of Electrical Machinery."

FRIDAY, JAN. 24...Royal Institution, Albemarle-street, W., 9 p.m. Colonel David Bruce, "The Extinction of Malta Fever."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) 1. Mr. J. R. Wade, "A Cost Theory of Reinforced-Concrete Beams." 2. Mr. E. I. Spiers, "The Neutral Axis in Reinforced-Concrete Beams."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m. Mr. J. H. Gibson, "Torsion Meters as Applied to the Measurement of Horse-power of Marine Steam Turbines."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. J. D. Forsyth, "Stained Glass."

Physical, Royal College of Science, South Kensington, S.W., 5 p.m. 1. Mr. W. Rosenhain, "Recalescence Curves." 2. Mr. W. C. M. Lewis, "An Experimental Examination of Gibbs' Theory of Surface Concentration regarded as the Basis of Adsorption, and an Application to the Theory of Dyeing."

SATURDAY, JAN. 25...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Gisbert Kapp, "The Electrification of Railways." (Lecture II.)

CORRECTION.—Page 160, col. 1, line 19, *for* Hall, *read* Lahore Museum. Mr. Coldstream was Secretary of the Lahore Museum, and recently Chairman of the "Galleries Sub-Committee" of the Indian Section of the Imperial Institute.

Journal of the Society of Arts.

No. 2,879. VOL. LVI.

FRIDAY, JANUARY 24, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 27, 8 p.m. (Cantor Lecture.) H. H. CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." (Lecture II.)

TUESDAY, JANUARY 28, 4.30 p.m. (Colonial Section.) A. BERRIEDALE KEITH, M.A., B.C.L., "The Development of Colonial Self-Government in the Nineteenth Century."

WEDNESDAY, JANUARY 29, 8 p.m. (Ordinary Meeting.) JOHN WILLIAM GORDON, "Reform of the Patent Law."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 20th instant, Mr. H. H. CUNYNGHAME, C.B., delivered the first lecture of his course on "Theory and Practice of Clock Making,"

The lectures will be published in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday evening, January 21st; H. H. CUNYNGHAME, C.B., in the chair.

The paper read was "Developments in the Art of Jewellery." By Mrs. HADAWAY.

The paper and discussion will be published in a future number of the *Journal*.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready and can be obtained by members on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

SHAW LECTURES ON INDUSTRIAL HYGIENE—I.

Friday, November 29, 1907; HERBERT LOUIS SAMUEL, M.P., Under-Secretary of State for the Home Department, in the chair.

The CHAIRMAN, in opening the meeting, said that some thirty years ago the late Mr. Benjamin Shaw left to the Society of Arts a sum of money, the object of which was to present prizes to inventors of any new processes or devices for avoiding danger to the life, limb, or health of persons engaged in industrial occupations. Although the offer had been frequently made by the Society, inventions were so few, or inventors were so modest that the prize had seldom been awarded in recent years; the result being that a fund had accumulated in the hands of the Society, which the Society thought could not be better spent, especially as it was known to be in accordance with the wishes of the testator, than in organising a series of lectures on industrial hygiene and the methods of prevention of danger and disease in industry. That, of course, was a matter which most keenly interested the Home Office, on whose behalf he had the honour to speak that evening. It was remarkable to how large a degree the State, in recent years, had entered into the sphere of hygiene and sanitation. In olden days, the State was regarded merely as an agency for the defence of property, the maintenance of order, and little else, occasionally diverting from its path to regulate trade, about which it knew little, and religion, of which it probably knew still less. It had now reached out its activities in a great variety of directions, and in none more remarkably than in relation to sanitation and hygiene. State action had extended into the sphere of sanitation and health in the direction of the drainage of towns, the sanitary condition of dwellings, the destruction of impure food, the prevention of adulteration, the checking or prevention of epidemics, the establishment of great Poor-law hospitals, and now the medical inspection of school children. Through such measures, and also through the growth of

medical science, a most astounding fall in the death-rate had been accomplished, which had been one of the most remarkable of sociological facts in recent years. In 1855, the death-rate of England and Wales was 22·6 per 1,000; in 1905, it was 15·2 per 1,000; showing a reduction in half a century of one-third. In other words, while 1,400 people now died every day, if the hygienic and social conditions which prevailed fifty years ago still existed, there would be 700 more people dying every day than now met their end. Amongst the latest of the efforts of the State with regard to hygiene had been its action in relation to the sanitation of factories and workshops, and the securing of greater healthiness of industry. Under the provisions of recent Factory Acts, the Home Office had made regulations for the protection of the life, limb, and health of the workers in twenty-seven of the most dangerous trades of the country; and at the present moment their overworked Factory and Industrial Departments had under consideration the making of special rules for five more of those dangerous trades. Last year Parliament enacted that industrial diseases were to be regarded as subjects for compensation under the Workmen's Compensation Act, in addition to industrial accidents. Those facts showed the growing and careful regard of Parliament and administrators for the health of the workers engaged in British industries, and in view of that one might look forward to the time when the principle would become recognised that there should be no such thing as industrial disease possible. They might be far away from that day, but he thought that was the goal, and no less a goal, towards which statesmen and administrators should bend their aims. It seemed to him to be a barbarous thing to set men to work of such a kind and in such a way that, as the direct and sometimes the inevitable outcome of their industry, their health was destroyed, and frequently their lives ended. Surely the evils which nature sent were numerous enough; it was monstrous that man, through his methods of industry, should add to them gratuitously. It was true that most employers in unhealthy industries did their best to minimise as far as possible the dangers to the health of their workpeople, but in many cases one was met by the plea that certain diseases must be looked upon as inevitable. The day was probably being approached when that inevitability would be recognised as nothing more than a euphemism for ignorance or apathy. It was the duty of scientists to discover the remedies for preventing industrial diseases, and he held it was one of the prime duties of the State as soon as the remedy was found to require that it should be adopted. A lecture was to be given that evening by Dr. Haldane on one of the most interesting of industrial diseases, that which came from working in compressed air. Accidents happened to men engaged in caisson and similar work, as in other industries, through the breaking of tackle or through some constructional defect, as so unhappily happened on the previous day at Blackfriars-bridge. But there was a special form of disease peculiar to working in compressed air, and directly due to the compression of the air in which the labour was exercised. As the law now stood, the preventive regulations which were undoubtedly desirable could not be made. A caisson was neither a factory nor a workshop, and the Factory and Workshop Act, which enabled regulations to be made for the safeguarding of workpeople in dangerous trades, did not therefore apply. Legislation would be needed before regulations could be made for that and some other industries coming under the head of engineering work, and he was not without hope that in the near future the Government might be able to persuade Parliament to pass the legislation which was the necessary preliminary to the working of regulations. The audience were grateful for the opportunity of hearing Dr. Haldane, who had given many years of study to that particular industrial disease; whose authority on it was second to none; and whom he had to thank specially for the assistance which he recently gave to a Committee of which he (the speaker) was the Chairman, on Compensation for Industrial Diseases under the Workman's Compensation Act, when he gave invaluable evidence and advice as to the treatment of that particular disease.

The lecture delivered was—

THE HYGIENE OF WORK IN COMPRESSED AIR.

By J. S. Haldane, M.D., F.R.S.,
Fellow of New College and Reader in Physiology, University of Oxford.

In the present lecture, I propose to give a short account of the causes and prevention of the peculiar physiological troubles and dangers to health, associated with work in compressed air.

Nature of Work in Compressed Air.

Men are employed in compressed air in connection with diving, and with a variety of works of engineering construction under water, or in soft water-bearing strata.

Diving.—The ordinary English diving dress (devised in its original form by Siebe) consists of a copper helmet screwed to a metal corselet, the latter being screwed water-tight to a stout water-proof dress covering every part of the body, except the hands, which project through elastic cuffs. Air is supplied through a non-return valve at the back of the helmet from a flexible pipe connected with an air-pump on surface. The air escapes through an adjustable spring valve at the side of the helmet. The arrangement is thus such that

the pressure of the helmet air is always equal to, or slightly greater than, the pressure of the water at the valve outlet. For every 33 feet (10 metres) of sea water (34 feet of fresh water) the pressure increases by one atmosphere, or nearly 15 pounds per square inch. At a depth of 33 feet, the diver is therefore breathing air at an excess pressure of one atmosphere, or an absolute pressure of two atmospheres, and every additional 33 feet will add one atmosphere to the air pressure. It is absolutely necessary that the diver should breathe compressed air. If the pressure in his helmet were less by a foot or two of water than that of the water at the same level his breathing would be instantly stopped, and he would die of asphyxiation. The diver is also provided with a so-called life-line, which commonly contains a telephone wire connected with a receiver in the helmet. Both life-line and air-pipe are used for signalling, according to a code. The boots and dress are heavily weighted, so that the diver may be able to sink and stand firmly on the bottom.

For some kinds of work a diving-bell is used instead of a diving-dress. The diver sits inside the bell until bottom is reached, and the air escapes through the open bottom.

Caisson Work.—In excavating the foundations for the piers of bridges over large rivers the men work in what are known as "caissons." A caisson is essentially a steel tube or box, open below, resting on the bottom, and so arranged that a working chamber at its lower end is kept free of water by compressed air, so that the men can excavate the bottom. As the excavation proceeds the caisson sinks, until a secure foundation is reached. The working chamber is then filled up with concrete, and the caisson, which has already been filled up above the working chamber with concrete, forms the outside of the permanent pier.

One or more tubes for access of men and removal of material communicate with the working chamber; and at the upper end of each such tube there is at least one air-lock. The air-lock is a small chamber with two doors closing air-tight, one of which opens from outside towards the interior of the lock, while the other opens towards the inner tube of the caisson. A man leaving the interior of the caisson enters the air-lock through the inner door, while the outer one is closed, the interior of the lock being of course filled with compressed air. He then closes the inner door, and lets the compressed air blow out from the lock through a tap. As soon as atmospheric pressure is reached he can open the outer door and come out. In going in a similar process is followed. By means of the air-lock men or materials can thus be passed in or out without allowing more than a small quantity of compressed air to escape.

The excess of compressed air escapes under the lower cutting edge of the caisson, so that free ventilation is usually secured. A somewhat similar plan is often used in sinking mine shafts through quicksand or other water-bearing strata near the surface.

Tunnelling Work.—In the work of constructing tunnels or "tubes" in soft strata beneath rivers or below the ground-water level, use is also now commonly made of compressed air for keeping out water or mud from the end of the tunnel. The men have thus to work in compressed air, going in and out through air-locks, as in caisson work. As examples of great engineering works carried out in this way, I need only cite the Blackwall-tunnel, or the Rotherhithe-tunnel, now approaching completion; or the various "tubes" passing under or near the river. I must not, however, dwell on the very interesting engineering side of the uses of compressed air, and I will now pass to the special physiological difficulties and dangers connected with the work and their avoidance.

Difficulties and Dangers of Work in Compressed Air.

Ear Troubles.—One of the first things usually observed by a man going into compressed air, or a diver descending, is a sense of pressure and discomfort in the ears. This may rapidly increase to acute pain. It is due to the fact that the middle ear is an air-cavity communicating only by a very narrow passage (the Eustachian tube) with the back of the nose. If the Eustachian tube does not admit air freely the air-pressure in the middle ear becomes less then outside. As a consequence the membrane of the drum of the ear is pressed inwards, and the blood-vessels of the wall of the middle ear are distended, so that either rupture of the membrane or bleeding is apt to occur, with resulting temporary impairment of hearing or inflammation, and occasional permanent effects.

Different persons vary greatly as regards the readiness with which their Eustachian tubes allow air to pass, and a cold in the head will often cause an almost complete blockage. By a peculiar swallowing movement at the back

of the mouth it is, however, usually possible to open the Eustachian tubes, and men accustomed to compressed air can do this without difficulty, and thus avoid all discomfort. A diver descending will naturally stop if he feels his ears uncomfortable. In an air-lock, on the other hand, the inlet tap is not usually under the direct control of the man whose ears are hurting him; and, as a consequence, there may be great risk of ear trouble. Besides the middle ear, there are other air-filled cavities, communicating by narrow openings with the nose cavity; and these also may give trouble if the openings are blocked. During decompression there is much less chance of trouble from this cause, unless the decompression is very rapid.

To avoid risk of injury to the ears or sinuses connected with the nose, the rate of rise or fall of pressure in the air-lock must be regulated according to individual susceptibility. One minute or less per atmosphere of pressure-rise is often not too fast, and a skilled diver can bear a more rapid rate; but other persons, and particularly new hands, require a much slower rate, while occasionally no reasonable rate is sufficiently slow, and the person must be returned to atmospheric pressure, and excluded from work. The man in charge of the air-lock should have strict directions to see that no one suffers pain. It also seems desirable to regulate the air-inlet, so as to avoid any very sudden rise of pressure. A tap, with an ordinary pressure governor between it and the air-pipe could easily be so arranged as to give a steady rise of pressure at a maximum rate of, say, one pound in four seconds, which could be instantly stopped, or slowed down if anyone suffered discomfort. With this arrangement, the admission of air would not be unduly slow at the end of the process. The rate of fall of pressure in the air-lock ought also to be governed, as will be further explained presently.

Respiratory Distress.—A second physiological trouble in connection with work in compressed air is well known to practical divers. It is commonly found that after a depth of 12 to 15 fathoms has been reached, the breathing becomes much oppressed, so that the diver's capacity for work is greatly diminished. With further increase in depth the distress becomes greater and greater. It has usually been attributed to the pressure on the body hindering the breathing.

The trouble arising from this cause in particular among the divers of the Royal Navy led to the appointment by the Admiralty in 1905 of a committee to investigate the conditions of deep diving, Captain (now Rear-Admiral) Hamilton being president, with Captains Bacon and Lees and myself as members, and Staff-Surgeon Rees as secretary. Many experiments were carried out for the committee, chiefly by Lieutenant Damant and Gunner Catto, then Chief Instructor in Diving at Portsmouth. The practical results of the committee's investigations are embodied in the "Diving Manual" recently issued to the Navy, and its full report is on the point of publication.

The first point investigated was the cause of the respiratory distress in deep water. It was soon found that there was nothing to account for it in the mere pressure of water or air on the body, and conclusive evidence was obtained that the carbon dioxide gas (CO_2) in the air breathed by the diver was the real cause.

In a paper published two years ago by Mr. Priestley and myself,* it was shown that under normal conditions the breathing is always regulated in such a way as to keep the partial pressure of the carbon dioxide in the air of the lung alveoli almost exactly constant. This fact was established by analysing samples of air from the lung alveoli, or air-cells, in man. To obtain a sample all that is necessary is to make a sudden deep expiration (during perfectly natural breathing) through a long piece of tubing of wide bore, and at once withdraw into a gas analysis apparatus a portion of the air left in this tube at the end of expiration. The deep expiration washes out all the more or less pure air contained in the air-passages and tube before expiration, and leaves the tube full of pure alveolar air. This pure alveolar air contains for each individual an almost astoundingly constant percentage of CO_2, if the barometric pressure is constant. If the barometric pressure varies the percentage of CO_2 varies inversely as the barometric pressure, so that the pressure exercised by the CO_2 itself remains constant. For instance, we found in ourselves that the mean percentage of CO_2 in our alveolar air was 6·01 at normal pressure, and 3·53 in compressed air at 1·7 atmospheres absolute pressure. The corresponding partial pressure of CO_2 in the alveolar air was 5·68 per cent. of an atmosphere, or 43 millimetres of mercury, during respiration at normal pressure, and exactly the same in the compressed air. Thus the respiratory centre

* *Journal of Physiology*, vol. xxxii., p. 225, 1905.

normally responds only to variations in the pressure of CO_2 in the blood which irrigates it. To variations in the pressure of oxygen it is within very wide limits absolutely indifferent. Only when the pressure of oxygen in the air inspired falls below about two-thirds of the normal does the respiratory centre begin to respond to want of oxygen. Quite recent experiments by Hill and Greenwood at high pressures in air, and by Boycott and myself at low pressures in a mixture of oxygen and air, have shown that at an absolute pressure of 6 atmospheres the alveolar CO_2 percentage was 0·9, and at 0·4 atmospheres it was 15, while at normal pressure it was about 5·5 with the same individuals. The pressure of CO_2 (*i.e.*, the percentage in the moist alveolar air multiplied by the barometric pressure) remained, however, quite constant.

If CO_2 is present in the air inspired the effect is to make the breathing deeper, and finally also more frequent. Unless, however, the pressure of CO_2 in the inspired air begins to approach the normal alveolar CO_2 pressure, there is very little change in the alveolar CO_2 pressure, compensation being produced very easily.

How, now, does this apply to the case of the diver? On account of the work involved in pumping, a diver has to content himself with a minimum supply of air. Let us suppose that when he is just under water he has sufficient air to prevent the CO_2 percentage in the helmet air from rising beyond 3 while he is at work. This will keep him fairly comfortable. If he now goes down 33 feet, the air supply being the same, the percentage of CO_2 in the helmet air will also remain the same. As, however, the pressure is now two atmospheres, his normal alveolar CO_2 percentage will be 2·8 instead of 5·6. It will, however, be quite impossible for him to maintain this percentage of CO_2 in his alveoli, since during work the percentage in the inspired air itself is 3. He will thus suffer from severe panting. A very little consideration will show that the diver must have twice as much air at 33 feet if he is to be as comfortable as he was at the surface, and at whatever depth he may be, his minimum air supply must be increased in proportion to the increase in the absolute air-pressure. In other words, the *volume* of air supplied to him, *measured at the pressure he is under*, must always remain the same.

To cut a long story short, we found that as soon as this condition was realised, as proved by numerous analyses of air from the helmet and measurements of the air supplied, the discomfort and loss of working power in deep water disappeared. Lieutenant Damant and Gunner Catto, the two officers who carried out most of the experiments in deep water, were as free from respiratory distress at 210 feet, the greatest depth hitherto recorded, as when they were just below surface. They could also reach this depth easily within two minutes, which showed the extraordinary fallacy in the time-honoured tradition that a diver should always descend slowly, so as to accustom himself by degrees to the change of pressure.

By guarding against excessive increase of carbon dioxide pressure in the air breathed by a diver, we not only increase greatly his working efficiency and comfort, but also obviate a serious danger. It not infrequently happens that a diver, particularly if he is somewhat unskilled, becomes unconscious or stupefied by the effects of carbon dioxide. The consequences of this may easily be fatal, as it is very dangerous to draw a man up rapidly from a great depth if he has been down for any time, and also dangerous to leave an unconscious man at the bottom.

In the caissons and tunnels it is also necessary to ensure sufficient ventilation to guard against ill effects from CO_2. To make the effects of CO_2 practically inappreciable it would be necessary to keep the pressure of CO_2 from rising above 1 per cent. of an atmosphere. Where there is no other source of CO_2 besides the persons present, a minimum ventilation of 300 cubic feet per man and per hour, measured at the existing pressure, would suffice for this end if the air were properly distributed. If this pressure were 30 lbs. this would correspond to 900 cubic feet, measured at atmospheric pressure. The possibility has to be borne in mind, however, of other sources of CO_2 and other air impurities. If candles are used, or if there is blasting, or decomposition processes are occurring in the mud, there may be present not only more CO_2, but also carbon monoxide, sulphuretted hydrogen, or other poisonous gases. As compressed air is expensive, it is important to avoid all unnecessary sources of air impurity, so as to render any excessive ventilation unnecessary. The air ought also to be properly cooled before it is delivered, as otherwise the working space becomes uncomfortably hot and work is hindered.

In the case of the Rotherhithe Tunnel the London County Council stipulated that the

percentage of CO_2 in the air should not exceed ·08 per cent., or an excess of about ·04 per cent. over the usual percentage in London air. This is far below anything which could have the slighest effect, and in such an excessively stringent standard I can see no object. It must have added considerably to the cost of the tunnel, and owing to the great difficulty in cooling such a large volume of compressed air the working space was rendered inconveniently warm, at any rate in summer. I understand that about 8,000 cubic feet of air, measured at atmospheric pressure, have been supplied per man employed and per hour. This is 40 times as much air as we found to be sufficient for a diver of the Royal Navy working in the same air-pressure. The conditions are of course very different; but 8,000 cubic feet seems to me an excessively large supply unless some definite reason can be given for it. About 2,000 cubic feet should be amply sufficient.

Compressed Air Illness, or Caisson Disease.—I now come to what is the most important special risk in connection with work in compressed air. Since the early days of diving it has been well known that after reaching surface divers in deep water are liable to sudden attacks of illness. Sometimes death occurs within a very short time, but paralysis, particularly of the legs and bladder, is much more common, so that the illness received the popular name of "divers' palsy." Often the paralysis passes off after a time more or less completely, but it may be permanent or may lead to a lingering fatal illness. Among workers in caissons and tunnels at high air-pressures similar cases of death or paralysis, or attacks of syncope, sometimes occur shortly after the men leave the air-lock in coming out. By far the most common symptom is, however, an attack of pain in one or other of the limbs, or occasionally elsewhere in the body. These pains are known to the men as "bends" or "screws," probably from the fact that the affected limb is usually bent to ease the pain, and that the pain itself is sometimes so intense as to feel like something being screwed into the affected part. The pains fortunately pass off soon. They usually occur within about an hour of leaving the air-lock. The whole group of symptoms has come to be known under the somewhat unfortunate name of "caisson disease," which suggests some sort of chronic malady.

The real explanation of all the varied symptoms of compressed air illness or "caisson disease" was furnished 30 years ago by the experiments and reasoning of the French physiologist, Paul Bert,* although up till recently the value of his work was not generally recognised, and various unfounded explanations of compressed air illness are to be found in medical literature. The recent experiments of Dr. Leonard Hill and his assistants in this country†, and of von Schrötter‡ and others abroad, have, however, removed all doubts, and added greatly to our knowledge of the subject.

When a gas is brought into contact with a liquid the latter takes up the gas in simple solution, apart from any chemical combination, until a state of saturation is reached. The amount thus taken up depends upon the "co-efficient of solubility" of the gas in the liquid and the temperature of the liquid, and varies directly with the pressure of the gas, in accordance with what is known as Dalton's Law. The blood passing through the lungs is practically in contact with the air breathed, and therefore takes up, when a man or animal is in compressed air, an increased proportion of nitrogen and oxygen in simple solution, in accordance with Dalton's Law.

The increased proportion of oxygen so taken up only adds slightly to the total oxygen in arterial blood, since far more is normally taken up in loose chemical combination with the hæmoglobin; and in any case nearly all the free (*i.e.*, uncombined) oxygen of the blood disappears when the latter reaches the tissues. Carbonic acid is of course also present in the lung air to the extent of about 5·6 per cent. at ordinary pressure; but the compressed air makes no difference as regards the solution of CO_2 in the blood, since, unless the air breathed is very foul, the pressure of the CO_2 in the lung air is kept constant by the breathing, whatever the total atmospheric pressure may be.

The increased proportion of nitrogen taken up by the blood in compressed air passes to the various semi-liquid tissues, which gradually also become saturated, since nitrogen, unlike oxygen, does not disappear by entering into chemical combination. The whole body thus gradually becomes saturated with nitrogen at the pressure (79 per cent. of the total atmospheric pressure) which this gas exerts in the

---

* *La Pression Barométrique*, Paris, 1878.

† Hill and Macleod, *Journal of Hygiene*, 1903, p. 401. Hill and Greenwood, *Proc. Royal Society*, B, vol. 77, p. 442, 1906; vol. 79, p. 21, and p. 284, 1907.

‡ Heller, Mager and v. Schrötter, *Luftdruckerkrankungen*, Vienna, 1900

compressed air. That the blood does actually become saturated with nitrogen in this way was shown by Paul Bert, whose results have been confirmed and extended by subsequent observers.

If the excess of air-pressure is now rapidly removed, as occurs when a diver comes quickly to the surface, or a worker in a caisson passes rapidly through the air-lock, it is clear that the blood and tissues will for a time be in a condition of super-saturation for the diminished pressure. In consequence of this the nitrogen will tend to liberate itself within the body in the form of bubbles, just as CO_2 is liberated in bubbles when the cork of a bottle of soda water is removed. When a liquid is saturated by contact with a gas the pressure exerted by the gas in solution is the same as that of the gas in contact with it. The gas in solution will tend to liberate itself in the form of bubbles if its pressure in the liquid exceeds the total external pressure. Thus if the blood and tissues be saturated with air at 4 atmospheres pressure (*i.e.*, at 3 atmospheres above normal) the nitrogen in solution will *tend* to liberate itself in bubbles as soon as the external pressure falls below 79 per cent. of 4 atmospheres, *i.e.*, below 3·16 atmospheres. It does not follow, however, that any actual, or at any rate any rapid, formation of bubbles will occur, particularly in the case of an albuminous liquid like blood; and the lowest pressure by rapid decompression from which a fatal accident has occurred in a caisson worker, is, so far as I have been able to ascertain, 23 lbs. per square inch, or 2·6 atmospheres of absolute pressure, corresponding to 53 feet of sea-water. The occurrence of symptoms of any kind is very seldom observed with pressures of less than 2.3 atmospheres, or 19 lbs. (43 feet of sea-water).

Paul Bert proved by numerous experiments on animals that sudden decompression from considerable pressures commonly causes death with symptoms of asphyxia, or else paralysis. The higher the pressure, and the longer within certain limits, the exposure to it, the more absolute the certainty of death becomes. On post-mortem examination of the bodies of the animals he found the veins in various parts of the body full of bubbles consisting almost entirely of nitrogen; and in the cases with symptoms of asphyxia the right side of the heart was full of froth, which had completely blocked the circulation.

The symptoms of paralysis were evidently due to partial or complete blocking of vessels supplying the spinal cord or brain; and in animals which had survived the paralytic attack for a few days, softening and the usual degenerative changes were found in the spinal cord at the places where the block had occurred.

By a suitable arrangement Hill and Macleod were able to see through a microscope the bubbles forming in the capillary blood-vessels of a frog's web. After keeping the animal at a pressure of 20 atmospheres for 10 minutes, during which the circulation went on as usual, they suddenly lowered the pressure to normal, and observed that "for about a minute after decompression the circulation remained unaltered, then small bubbles were seen, first one, and then numbers scurrying through the vessels and driving the blood corpsucles before them. In a moment or two the vessels became entirely occupied with columns of air bubbles, and the circulation was at an end." By means of rapid recompression the gas was again driven into solution, and the circulation was re-established, the animal being uninjured.

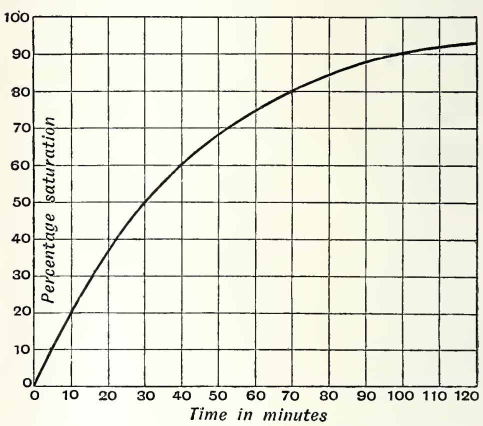
The results of post-mortem examinations of the bodies of men who have died of compressed-air illness have entirely confirmed Paul Bert's conclusions. He pointed out, and partly proved by experiments on animals, that, in order to avoid compressed-air illness, slow decompression is necessary. He did not, however, show how slow the decompression required to be in order to secure safety, nor has human experience solved this problem. What we do know is that when the excess of pressure has exceeded about 1½ atmospheres, or 22 pounds, the rates of decompression hitherto employed have proved more or less unsafe if the exposure has been long continued; and that the higher the pressure the greater is the danger with a given period of exposure. At great depths, such as 30 fathoms, or 80 lbs. pressure (5·4 atmospheres of excess pressure) an exposure of even 10 minutes has proved dangerous. Heller, Mager and von Schrötter have laid down a rule that for each atmosphere of excess pressure an allowance should be made of 20 minutes for each atmosphere of decompression, and that the decompression should be at a uniform rate. This rule is based partly on calculation and partly on the experience that a less slow rate is unsafe with long exposures at a pressure of about 30 lbs. The rule is doubtless a great advance in some respects on what has been the practice hitherto, but the calculation on which

it is based is unsound. There is no real evidence that it would afford safety for pressure of even 30 lbs., while for pressures below 20 lbs. a much faster rate of decompression is well known to be practically safe. It also takes no proper account of the duration of exposure; and indeed von Schrötter expresses the opinion that after 20 minutes the body is practically saturated with nitrogen, so that any further exposure is of almost no importance. This is wholly contrary to all practical experience.

In view of the unsatisfactory state of knowledge as to what is a safe rate of decompression, it was evident at the outset of the Admiralty enquiry that a thorough investigation of the whole subject was needed; and, meanwhile, the means of carrying out the necessary experiments had been provided. I had mentioned to Dr. Ludwig Mond, to whom scientific investigation in this country already owes so much, the need for a large experimental steel chamber for experiments on animals and men under varying air-pressures. He generously offered to provide such a chamber for the Lister Institute of Preventive Medicine. It was erected under his direction by Messrs, Lennox and Co., and is large enough to hold several men or large animals, together with any necessary apparatus, and to resist pressure up to about 100 lbs. By arrangement with the Lister Institute and the Admiralty, the experiments in the chamber were undertaken by Dr. A. E. Boycott, of the Lister Institute, Fellow of Brasenose College, Oxford, and Lieut. Damant. Towards the expenses of the experiments liberal contributions were also made by the members of three well-known engineering firms—Messrs. John Aird and Sons, Messrs. S. Pearson and Son, Ltd., and Messrs. Price and Reeves. Some additional apparatus was also provided by the Admiralty. During the last two years several hundred experiments have been made in the chamber on goats and other animals, and on men, besides numerous diving experiments at sea; and I shall endeavour to indicate briefly the theoretical considerations which we had in view and some of the main results.*

First of all we had to consider in what way the process of saturation of the body with nitrogen occurs during exposure to compressed air, and the process of de-saturation on return to normal pressure. From the existing evidence as to the mode of action of the lungs, it seems certain that, whatever the pressure of nitrogen in the air breathed may be, the arterialised blood leaving the lungs will be practically saturated to the same pressure. On exposure to compressed air the unsaturated venous blood will become saturated in passing through the lungs; and on return to a lower air pressure the supersaturated venous blood will become de-saturated. On exposure to a high air pressure saturated arterial blood will be flowing from the lungs towards all parts of the body. But these parts are just as capable of taking up an excess of dissolved nitrogen as the blood is. Hence during its passage through the body-tissues the blood will lose most of its nitrogen to the tissues; and the venous blood returning to the lungs will

Fig. 1.



Curve showing Approximate Rate of Saturation of Parts of the Body with an average rate of Circulation and Percentage of Fat.

contain very little of the excess of nitrogen with which it started. In the lungs, however, it will be charged up again, though the amount which it gains there will of course not be quite so great as at the previous round of the circulation. At the next round the amount carried away will be still less, and so on. It will easily be seen, therefore, that the process of saturation of any part of the body with nitrogen must be capable of being graphically represented by a logarithmic curve (Fig. 1). Supposing, for instance, that any part of the body becomes half-saturated in half-an-hour, it will be three-quarters saturated in an hour, seven-eighths saturated in $1\frac{1}{2}$ hours, and so on. The process of de-saturation on return to a lower pressure must take place in a similar way, provided there has been no formation of

* For a full account of these experiments I must refer to a forthcoming paper in the *Journal of Hygiene*.

bubbles, or anything else to complicate the conditions.

The time actually required to produce any given degree of saturation or de-saturation in any part of the body remains, however, quite uncertain so far. Some parts of the body have a very rapid circulation, and will therefore saturate and de-saturate quickly. Other parts, however, have a small circulation of blood in proportion to their mass, and must therefore saturate and de-saturate slowly. Judging from existing physiological data we, at first, over-estimated the rate at which saturation and de-saturation occur. This over-estimate was partly due to our ignorance of a fact which emerged during the investigation, namely, the fact that fat dissolves about six times as much nitrogen as blood. We had noticed that, in animals which had died after rapid decompression, the fat was often full of fine gas bubbles, and remembered that, in the course of a quite different investigation, Dr. Vernon of Oxford had found that oils dissolve more nitrogen than water does. He made some further accurate determinations for animal fats, with the result just mentioned.* The fat scattered throughout the body thus acts as a reservoir for nitrogen; and this probably about doubles the time needed for saturation to occur.

To obtain a practical estimate of the time required for saturation of the body, Dr. Boycott and Lieutenant Damant made a number of experiments on goats in order to see how far the frequency and severity of the symptoms increased with the duration of exposure. The accompanying Table shows some of the results. It will be seen that the symptoms increase with the duration of exposure up to at least two hours, and probably rather more. From these and other data we concluded that in goats some parts of the body giving rise to symptoms on decompression are not more than half-saturated in 45 minutes, and will de-saturate with corresponding slowness. The rate of circulation in man is only about two-thirds as fast as in goats. Hence, in man, there will be some parts of the body which only half saturate in $1\frac{1}{4}$ hours. Previous investigators have inferred that saturation and de-saturation occur far more rapidly than this; but our conclusions are in accord with practical experience in caisson work. Mr. E. W. Moir, M.Inst.C.E. (of Messrs. J. Pearson and Son, Ltd.) who has given great attention to the whole subject and introduced important measures for the safety of workers in compressed air, assures us that even after three hours exposure to compressed air the cases of illness are less frequent than with longer exposures; and similar evidence has been brought forward by Mr. G. W. M. Boycott.* This can be well understood if the rate of saturation is so slow.

TABLE I.

Absolute pressure 4 atmospheres.

Exposure in minutes.	Decompression in minutes.	Number of goats.	Cases of "bends."	Severe symptoms.
15	1	15	1	0
30	1	15	3	0
60	1	14	4	0
120	1	10	4	2
60	10 (uniform)	11	3	1
120	10 ,,	11	4	1
240	10 ,,	11	4	1
480	10 ,,	11	3	2

Another point which clearly emerges from our experiments is that it is only the slowly saturating and de-saturating parts of the body which give rise to danger with any ordinary pressures. This also is in accord with human experience. In very small animals, in which the rate of saturation and de-saturation is far faster than in men or goats, no symptoms at all are produced by even sudden decompressions from pressures of 75 pounds. It was for this reason that we selected goats for most of our experiments. Fairly large animals seemed essential.

I now come to another point, as to which we have been led to new and important conclusions. Practical experience of work in compressed air shows that even with very rapid decompression, no symptoms of caisson disease occur with an absolute pressure of less than two atmospheres, and that symptoms are very rare and slight until the pressure rises beyond 2·3 atmospheres, or 19 pounds per square inch. This we found to be true also for goats. Now, if it is possible to decompress rapidly and with safety from two atmosphere, or a little more, to one atmosphere, it seemed likely that it would be possible to decompress with equal safety from four atmospheres to two, or from six to three, since the volume of gas tending to be liberated would be the same in each case. Experiment showed that this was the case, and that the danger of rapid decompression depends, not on the absolute difference

* *Proc. Royal Society*, B, Vol. 79, p. 366.

* *Proc. Inst. of Civil Engineers*, Vol. clxv., p. 231.

between the initial and final pressure, but on the proportion between the two pressures. If this proportion is only 2, or 2·3, to 1 the decompression is safe; if, on the other hand the proportion is 3 or 4 to 1, the decompression is dangerous. This is illustrated by the experiments in Table II:—

TABLE II.

Absolute pressure in atmospheres.	Exposure in minutes.	Fall of pressure in atmospheres.	Relative reduction of pressure.	Duration of decompression in minutes.	Number of goats.	Cases of "bends."	Severe symptoms.	Death.
6	180	3·4	2·3 to 1	$1\frac{1}{2}$	10	0	0	0
4·4	180	3·4	4·4 to 1	4	10	3	3	2
4	120	3·4	6·7 to 1	6	3	1	1	1
3·6	120	3·0	6 to 1	6	4	0	3	0
4	120	3·0	4 to 1	1	10	2	4	0

A rapid drop from 6 to 2·6 atmospheres produced no symptoms at all, the fall of pressure being 3·4 atmospheres, and the relation of the higher to the lower pressure being 2·3 to 1. With the same animals decompression from 4·4 atmospheres to 1 produced disastrous effects, the fall of pressure being exactly the same as before, but the relation of the higher to the lower pressure being now 4·4 to 1.

The method hitherto recommended for bringing men safely out of compressed air has been to decompress at a slow and uniform rate. But calculation on the principle already referred to shows that, however slow this uniform decompression may be, the difference in partial pressure between the nitrogen dissolved in the tissues and the external air-pressure will go on increasing during the decompression. Still more will the proportional difference between the two pressures increase. At the end of the decompression, therefore, the danger, if any, will be at a maximum, whereas during the first half, or more, of decompression time is simply being wasted, or much worse than wasted, if saturation of the body has been incomplete, as is always the case in diving. All our experiments confirmed this theoretical deduction. These considerations led us to introduce a new method—that of decompression in graduated stages. The principle of this method is that the diver or worker in compressed air is brought rapidly to half the absolute pressure (or a little further if his tissues are not saturated), stopped there for a time, then decompressed a little further after sufficient time has elapsed to allow the maximum nitrogen pressure in any part of his body to become not more than twice the nitrogen pressure of the air at the lower stage. He is then brought on by further stages on the same principle until he reaches atmospheric pressure. For the difference between the stages a pressure of 0·3 atmospheres was selected, corresponding to 10 feet of sea-water. The diver's progress is of course controlled by signal from surface according to the indications of the pressure-gauge on the pump. The proper stoppages, after stays at different depths, and for different periods of time, have been carefully calculated and put into the form of a Table, which is now in use in the British Navy. A small portion of

TABLE III.—PORTION OF DIVING TABLE FOR BRITISH NAVY.

Depth.		Total pressure in atmospheres.	Time from surface to beginning of ascent.	Depth and duration in minutes of stoppages during ascent.				Total time for ascent.
Fathoms.	Feet.		Minutes.	40 feet.	30 feet.	20 feet.	10 feet.	Minutes.
18–20	108–120	4·6	Up to 15	—	2	3	7	15
			15–25	—	5	5	10	23
			25–35*	—	5	10	15	33
			35–60	5	10	15	25	57
			60–120	10	20	30	35	97
			Over 120	30	35	35	40	142

* Ordinary limit of time.

this table is shown (Table III.). This diving table extends to depths up to 204 feet.

For ordinary diving work the Table limits the stay on the bottom in such a way that the diver can come up safely within half-an-hour. This is desirable for many reasons. After prolonged stays on the bottom at great depths the time required for safe decompression, even by the stage method, is far too long ; and with uniform decompression many hours would certainly be needed at the greatest depths.

The method of stage-decompression was very thoroughly tested on goats, and compared with the old method of uniform decompression. The result was to show, we think, beyond all question that the stage-decompression method is greatly superior, particularly for diving work. Even when the rate of decompression was much too fast by either method, stage-decompression proved considerably safer. Table IV. shows a number of results obtained with the same animals and under the same conditions, except that the method of decompression was varied. It should be remarked that in each series except C, the rate of stage-decompression was less slow than what was calculated to be required for goats in order to prevent all symptoms, and considerably so in series B, D, and E. The occurrence of some symptoms was therefore expected. It will be seen, however, that deaths and severe symptoms were eliminated by the stage-decompression, whereas a number of cases occurred with uniform decompression in the same time, besides a much greater number of slight cases.

With goats we found it necessary to provide for parts of the body taking as much as forty-five minutes to become half-saturated or half-desaturated after a given alteration of pressure. For man we therefore consider it necessary to provide for parts requiring seventy-five minutes, as the respiratory exchange per unit of body weight in man is three-fifths that of goats.

A number of experiments in the chamber at absolute pressures up to 6½ atmospheres, were carried out on men, with stage-decompressions ; and many dives in the sea to pressures of from 4 to 7⅓ atmospheres have also been made by Lieutenant Damant and others, with the time-limits and stage decompression recommended in the new diving tables. No symptom of caisson disease has, however, been observed, so that the new method appears to be practically successful.

The old method was to go down and come up slowly, at a rate of about five feet per minute. Figures 2 and 3 show the calculated degree of saturation of different parts of the body during a dive to 6 atmospheres pressure for fourteen minutes with the old and the new method. It will be seen at once that the slow descent adds greatly to the danger, while during most of the uniform ascent many parts of the body are actually increasing in saturation, so that by the old method a diver runs a very serious risk of death or paralysis when he reaches surface. By the new method this risk is avoided, and the total time under water is reduced to nearly half. To obtain equally safe results by the method of uniform decompression it would, to judge by the experiments on goats, be necessary to extend the duration of decompression to several hours, the reason being that, in the case of short exposures to high pressure, not only is time wasted during the first half, or two-thirds, of the uniform decompression, but the saturation of most parts of

TABLE IV.—ABSOLUTE PRESSURE 6 ATMOSPHERES.

Series.	Exposure in minutes.	Decom-pression in minutes.	Number of goats.	Stage Decompression.			Uniform Decompression.		
				Cases of "bends."	Severe symp-toms.	Deaths.	Cases of "bends."	Severe symptoms.	Deaths.
A	15	31	35	5	0	0	13	3	1
B	30	31	6	2	0	0	4	1	0
C	30	68	14	0	0	0	7	0	0
D	120	70	13	4	0	0	7	2	0
E	120	92	19	3	1	0	3	5	1
F	180	133	10	2	0	0	5	0	0
Total			97	16	1*	0	39	11†	2

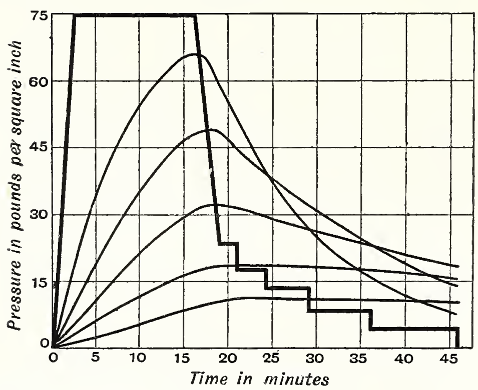
* Paralysis of foot lasting 1 hour.

† 3 cases of paraplegia, 4 of temporary paralysis, 2 of dyspnœa, and 2 of undefined illness.

the body continues to increase very seriously, so that at the end the decompression rate is far too fast unless the process is made very slow indeed. Uniform slow decompression thus seems to be quite impracticable for diving in deep water.

In the case of caisson and tunnel work, the conditions are somewhat different from those in diving. In the first place, the pressures are not so high, while the period of exposure is usually longer—seldom less than three hours in the case of ordinary workmen. In the second place, there is not the same need for limiting the time spent during decompression,

Fig. 2.



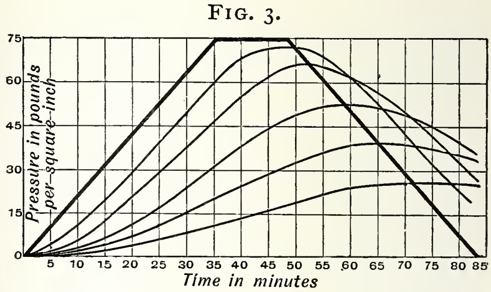
Diving to 28 Fathoms by new Method.—The curves from above downward represent respectively the variations in saturation of parts of the body which half saturate in 5, 10, 20, 40, and 75 minutes. The thick line represents the air pressure. Diver 14 minutes on the bottom, and 46 minutes under water.

and therefore also limiting the period of exposure. Another important difference is that the occasional occurrence of symptoms in the air-lock is not a matter of such importance as in the case of a diver under water. The man in the air-lock has others to look after him, and he can be promptly relieved by raising the pressure. The occurrences of symptoms after he leaves the lock seems to be a matter of more moment; as it might be some time before he could be re-compressed, and he might have no one to help him.

Bearing in mind these circumstances, it seems desirable to adopt a somewhat slower rate of decompression in the case of caisson workers then in the case of divers who have been equally long exposed, and to make the decompression more gradual towards the end, so as to avoid any risky state of super-saturation in the body of a man after leaving the air-lock. The slow part of the stage-decompression then becomes theoretically very nearly uniform, so that a uniform rate may well be adopted. This considerably simplifies the carrying out of the slow part of the decompression, and the directions for the whole process.

The initial rapid stage would be to half the absolute pressure; and no slow stage at all would be needed if the pressure in the caisson did not exceed about 2·2 atmospheres in absolute measure, or 17½ pounds of excess pressure, since practical experience seems to show clearly that it is safe to decompress in three minutes from 17½ pounds pressure, or a little more. One or two exceptional cases where symptoms have occurred, though not of a serious nature, are, however, on record.

Fig. 3.



Diving to 28 Fathoms by old Method.—The thick line represents the air pressure. The curves, from above downwards, represent respectively the variations in saturation of parts which half saturate in 5, 10, 20, 40, and 75 minutes.

In order to avoid any chances of mechanical injury to the ears, and to keep within limits tested by practical reference, I think that not less than two or three minutes should be allowed for the initial rapid decompression, and that the outlet tap should be so regulated as to prevent a faster rate. If two or three minutes in all were taken the rate of fall of pressure would, however, naturally be much faster at the beginning than the end of the process, which would be an advantage. An accurate and easily read pressure gauge in the lock is of course essential, and it would also be desirable to have a graphic record of each decompression. The accompanying Table shows the rate we have calculated as safe after the first rapid stage has been completed in three minutes. In order to make the Table more practically useful, we have taken into account that men will usually come out for meals after periods of about three hours' work, and that since they will not have time

to de-saturate during the interval, they will be more highly saturated after a second or third period of work than after a first. The figures for a continuous exposure are also given.

To illustrate the use of the Table we may first suppose that the pressure in the caisson or tunnel is 23 lbs. by gauge, corresponding to an absolute pressure of $23 + 15 = 38$ lbs. The pressure in the lock can be reduced in three minutes to $\frac{38}{2} = 19$ lbs., corresponding to an excess pressure of 4 lbs. by gauge. The pressure will then be allowed to fall to normal, either uniformly, or by about a pound at a time, in $4 \times 3 = 12$ minutes, so that 14 minutes in all will be spent in the lock after the first spell of about three hours' work. After a second or third spell, 22 minutes will be needed. With a continuous exposure all day, 30 minutes would be needed.

TABLE VII.—SHOWING RATE OF DECOMPRESSION IN CAISSON AND TUNNEL WORK.

Working pressure in pounds per square inch.	Number of minutes for each pound of Decompression after the first rapid stage.		
	After first three hours' exposure.	After second or third three hours' exposure, showing an interval for a meal.	After 6 hours or more of continuous exposure.
18–20	2	3	5
21-24	3	5	7
25-29	5	7	8
30-34	6	7	9
35-39	7	8	9
40-45	7	8	9

If the pressure were 40 lbs., the pressure in the lock would be reduced in three minutes to $\frac{40 + 15}{2} = 27\frac{1}{2}$ lbs. of absolute pressure, or $12\frac{1}{2}$ lbs. pressure by gauge. The subsequent slow stage would occupy $12\frac{1}{2} \times 7 = 88$ minutes after the first 3-hour spell, and $12\frac{1}{2} \times 8 = 112$ minutes after six hours or more continuously in the compressed air.

It will be seen that at high pressures there would be a saving of time in the lock if the men remained continuously in the compressed air. The time in the lock is, however, in any case very long at the higher pressures. This seems inevitable if a reasonable standard of safety is to be reached; and the aim of the Table is to give about the same safety for work at over 20 lb. pressure as exists at present with work at under 20 lbs. Such a standard can only be reached by giving the necessary time for decompression, and I must express the very distinct opinion that the rates of decompression hitherto usually adopted are unsafe, particularly if the decompression is uniform; also that the rate of uniform decompression recommended by Von Schrötter, and the method which has been made legally compulsory in Holland,* are insufficiently safe for pressures much exceeding 25 lbs.

With such long times spent in an air-lock, ventilation becomes necessary; and in order to permit of this it would probably be convenient to have an outlet provided with an adjustable safety-valve, so that the pressure could be kept steady at any point in spite of the influx of air. The lock should be large enough for a whole shift, and should contain an electric heater and telephone.

In order to avoid the tedious and prolonged stays in a small air-lock, it would probably be convenient in many cases to arrange for a roomy air-lock, or section of tunnel, kept at a constant pressure of $\frac{1}{2 \cdot 2}$ of the absolute pressure in the working space, with two small locks for passage to the working space, and to the outside. The men could be detained in this "purgatory" air-lock for the necessary time, and then proceed rapidly through the small lock to the outside. By this plan no lock would be blocked for more than three minutes at a time, and if the men could wash, change, and take meals in the "purgatory" lock a great saving of time would be effected. If, for example, the working pressure were 30 lbs., the "purgatory" lock could be kept at $5\frac{1}{2}$ lbs., and the men would need to stay in it about 50 minutes on their way out.

With the precautions just indicated there should be no need for a resident doctor in connection with work in compressed air. Except in large undertakings, a medical air-lock for recompression might, perhaps, also be dispensed with, as any exceptional case could be dealt with by recompression in the ordinary lock. The medical air-lock, which was first introduced by Mr. E. W. Moir, and has saved many lives, is doubtless invaluable where the decompression process is too rapid; and recompression, promptly applied, is by far the best treatment for any case of compressed air illness. We ought, however, to abolish the need for recompression.

* According to these regulations the decompression is slow at first and more rapid afterwards, thus completely inverting the proper mode of decompression.

A medical examination of the men admitted to work in high air-pressures is, however, very necessary. All men suffering from chronic disease, alcoholic excess, ear troubles, &c., should be excluded, as well as men who are at all fat, or are over 45, or who have ever had any serious symptoms after a reasonably slow decompression, since such an occurrence points strongly towards excessive susceptibility to compressed-air illness.

My time is already more than exhausted, and there still remain many points on which I should like to touch. I have endeavoured, however, to put the more essential facts before you, and to explain the main reasons on which the precautions advocated in this lecture are based. These precautions are in excess of those hitherto employed; but I think that any expense or inconvenience involved in carrying them out will be amply compensated for, not only by the avoidance of illness and anxiety, but also by increased freedom in the employment of whatever pressures may be deemed desirable for the proper accomplishment of the undertaking in hand.

The CHAIRMAN thought the audience would wish to express its thanks to Dr. Haldane for the most interesting lecture he had delivered. Looking at it from the professional point of view, the point which had struck him, and he had no doubt had also struck the many officials of the Home Office, whom he was pleased to see present, was that it would not be easy to frame the rules which would be necessary for the prevention of compressed-air illness when the necessary legislation was passed. When the human body was assimilated to a soda-water bottle, the rules for drawing the cork would not be simple. The audience was small, but he assured the author it had been most keenly interested in what he had said. Those present would leave the meeting saturated with information on compressed-air illness, and he hoped they would not de-saturate too promptly, or with unpleasant symptoms. They had listened to a most important contribution to the scientific knowledge of the subject; and in the name of the members of the Society he expressed their most cordial thanks to Mr. Haldane for his address.

Sir ALEXANDER BINNIE, in seconding the vote of thanks to Dr. Haldane, said that having for six years been subject to air pressures up to 30 lb., and for another three years to even greater air pressures, he was somewhat conversant with the subject of the lecture. The author had brought forward a great many new facts, which, as the Chairman had observed, were somewhat difficult of application in drawing up regulations for actual working. There was one point, however, to which he desired to draw attention as a representative of the Home Office, namely, the precautions which were taken when the construction of the Blackwall Tunnel was commenced in 1890. The late Sir Benjamin Baker and himself determined that it would not be economical to work at a greater pressure than 30 lb. above the atmosphere; that was for the purpose of determining the depth at which the tunnel was to be driven below the river. When they made their report, which was accompanied by a statement of the possible disease following the use of compressed air, to the Committee, the County Council at once applied to Parliament for powers to enable them to compensate the relatives of the men who were injured while working in compressed air. They worked for six years at pressures varying from 25 lb. to 30 lb., and he was glad to say only one occasion occurred when it was necessary to use that Act. That was a very advanced case of Meniere's disease, brought on by the rupture of the tympanum of a man who entered compressed air in an incautious manner. He stated those facts in order that those present might understand that, with proper precautions such as the author had pointed out, under moderate pressures it was quite possible to carry on work of the character he had described with practical immunity to the men employed. It must always be borne in mind, however, as Dr. Haldane had pointed out, that some men could, whilst others could not, stand air pressure, and it was only by careful medical inspection in the first instance that it was possible to eliminate from the candidates those who were not likely to prove successful workmen.

SEVENTH ORDINARY MEETING.

Wednesday, January 22nd, 1908; SIR STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Baker, Sir Augustine FitzGerald, M.A., 56, Merrion-square, Dublin.

Brown, Edward O. Forster, Springfort, Stoke Bishop, Bristol.

Brown, John Hewlett, White-house, Whiteley-wood Green, near Sheffield.

Carmichael, John, 10, Cortayne-road, S.W.

Casey, Ernest, Thatched-house Club, 86, St. James's-street, S.W.

Garnett, William James, British Legation, Peking, China, and Quernmore Park, Caton, Lancashire.

Knowles, William, Treacher's-buildings, Bombay, India.

Porter, Robert, 37, Chalmers-street, Edinburgh.

Rogers, William David, F.C.S., 36, Grange-road, Smethwick, Staffs.

Singal, Thakur Shiam Sarup, M.R.A.S., Rais, Dibai, O. R. Railway, U.P., India.

The following candidates were balloted for and duly elected members of the Society:—

Brierley, Harry H., 8, Oaklands-road, East Sheen, S.W.

Christy, Cuthbert, M.B., C.M. (Edin.), care of Messrs. Smith, Mackenzie and Co., Mombasa, British East Africa, and Royal Societies Club, St. James-street, S.W.

Coats, Matthew, F.C.I.S., 82, Ham-park-road, Forest-gate, E.

Gilbert, Reginald, F.Z.S., Llanelwedd-hall, Builth Wells, Breconshire, North Wales.

Reid, Alexander Scott, Assoc.Inst.M.M., care of The Waihi Gold Mining Company, Limited, 11, Abchurch-lane, E.C.

Tarapore, P. C., F.R.G.S., Sutherland-house, 2, Greencroft-gardens, N.W.

The CHAIRMAN, in introducing the reader of the paper, said that Mr. Hillman was for some years the editor of a newspaper in Bangkok, and under those circumstances he naturally came more closely into contact with the different classes of Siamese life, political, social, and commercial, than in almost any other position he could have occupied. He used to publish at the end of each year a special report on the trade of Siam, and was the second editor of a bi-lingual newspaper, half Siamese and half English, which had a Siamese staff. He (the Chairman) had had the pleasure and privilege of reading the paper which was about to be read, and was quite sure that the audience would be as much interested in it as he had been himself, which was saying a good deal, for he was intensely interested in it.

The paper read was:—

SIAM: THE COUNTRY, THE PEOPLE, AND THE TRADE; AND THEIR RELATIONS WITH GREAT BRITAIN.

By HARRY HILLMAN

(Editor of the *Retford, Worksop, and Gainsborough Times*, and one time Editor of the *Siam Observer*).

It is now 13 years since a paper was last read to this Society on Siam. It was in May of 1894 that Mr. Charles Stuart Leckie, of the Borneo Company, and one of the most respected of Bangkok's commercial men, dealt with the commerce of Siam in relation to the trade of the British Empire. Since then the tide in the Menam has risen and fallen many times, and the fortunes of this last of the Buddhist kingdoms have undergone many changes. The visit of Siam's king to Europe last summer aroused renewed interest in the country, and those who wish it best are glad to know that his tour marks the termination of a long period of stress during which the future of Siam as an independent State has hung in the balance. Happily the long dispute with France is over, and whereas any time the last ten years my paper would have necessarily consisted largely of an explanation of the many confused points in dispute, I am this evening able to leave this unpleasant topic almost on one side. The disputes are settled, amity has displaced enmity and distrust, and the columns of French newspapers that once were filled with abuse of the Siamese, and of us British as upholding them, are now just as effusively complimentary to us both. In no direction is this change more marked than in the columns of the *Siam Free Press*, the editor and proprietor of which was expelled from Siam because of the nature of his writings and the telegrams he despatched to the European Press. In a copy of this paper, recently to hand, there is a leader defending the Siamese administration against what it declares to be the unreasonable attacks of the Straits newspapers.

Many will recall the previous visit of the King of Siam to Europe, ten years ago. I was in Siam at that time, and was greatly struck by the evidences of his happy relationships with his people that were called forth in connection with that tour. One generally pictures the Asiatic as being very little concerned as to the *personnel* of his rulers, so long as the burden of taxation be not too heavy, and the encroachments upon his liberty not too patent. In Siam, however, a very different spirit was manifested, and the return of their monarch was a cause for rejoicing in all ranks. An ayah in my household, for instance, one of a class of native who would not in the ordinary way be expected to show much emotion over such an event, was so enthusiastic about it that her mistress asked her, with some surprise, what it had to do with her. She replied, with a wealth of feeling, "Oh! Mem, he made us to stand up."

These few words call for explanation, and in that explanation will be found the way to the whole position as regards the King and his people. The sense of liberty is very strong among the Siamese, and despite what has been written about them by some superficial

observers, I have found among them a great degree of pride of race and true patriotism. And, indeed, they have every reason to be proud. The unmeaning title by which we know them is unknown to themselves. They are the K'un T'ai—the Free people; and their country is Muong T'ai—the Free country. That title has been proudly borne, and with a great deal of reason, ever since they have been a race. We first hear of them as a small tribe in the south of China; while near relatives of the Siamese are still to be found in the Ikia, of the Kwang-si province, one of the many tribes of China which have never been completely merged into the Chinese nation. Scorning the defeat which was inevitable, in the course of the long struggle of 4,000 years ago, during which the Chinese Empire was consolidating, this tribe migrated into the hills to the south of them, always known by the name which this spirit of independence earned for them—the Free. As centuries passed, the tribe grew in numbers, and eventually became two tribes. These, the Greater and the Lesser T'ai, became in time the masters of Siam, Annam, and Cambodia. They have been in constant conflict with their neighbours, right down to modern times; but in every struggle added lustre to their name. Abandoned capitals of the past mark their progress downward along the valley of the Me-nam - or Mother Water —as the main river of Siam is picturesquely and appropriately named. The founding of the present capital, Bangkok, marks a point in their history such as we ourselves might be proud to be able to boast of. The Burmese, the hereditary enemies of the Siamese, in 1767 sacked the then capital, Ayuthia, scattered the army, and annihilated the royal family. All the provinces at once revolted, and Siam seemed to have ceased to exist. But notwithstanding this crushing blow, she recovered, drove the Burmese back within the year, reconquered the revolting provinces, and founded the new capital which was destined to outshine the old. Such in brief is the justification of the Siamese to their title of the free people.

But like many other nations of the past, the Siamese did not find their boasted freedom incompatible with the existence among them of a system of domestic slavery; while such has been the position of their kings that even the nobles had to grovel in their presence, and the common people were not permitted to look at them at all. When the present King came to the throne he abolished both these customs, and now no slaves can be born in his dominions; and not even the lowliest of his subjects need hesitate to stand up in his presence. This was what the Ayah was alluding to, and the subsequent policy of the King has been in thorough keeping with the auspicious inauguration of his reign. The first step has been followed by many others, all tending to the elevation of the people, and it is this which has presented us with the phenomenon of an Eastern monarch beloved of his people.

King Chulalongkorn was born in 1853, and succeeded his father, himself a ruler of remarkable ability and foresight, in 1868. He imbibed very liberal ideas from the American missionaries who were at work in the country even as long ago as that. But he has suffered from the drawback—not unknown to autocrats in Europe—of not having at his command a sufficient number of really efficient lieutenants. Two of his ablest supporters have been his half-brothers—Prince Devawongse, who has held charge for many years of the ministry of Foreign Affairs, and Prince Demrong, who has held several administrative positions, but none so brilliantly as that of Minister of the Interior, which was created in 1895. Two others who should also be mentioned are Prince Bidyalabh, Minister for Public Works, and one time minister to this country, under whom the railway system of the country has been initiated; and Prince Rabi, who has been responsible for the great reforms which have been instituted in the administration of justice.

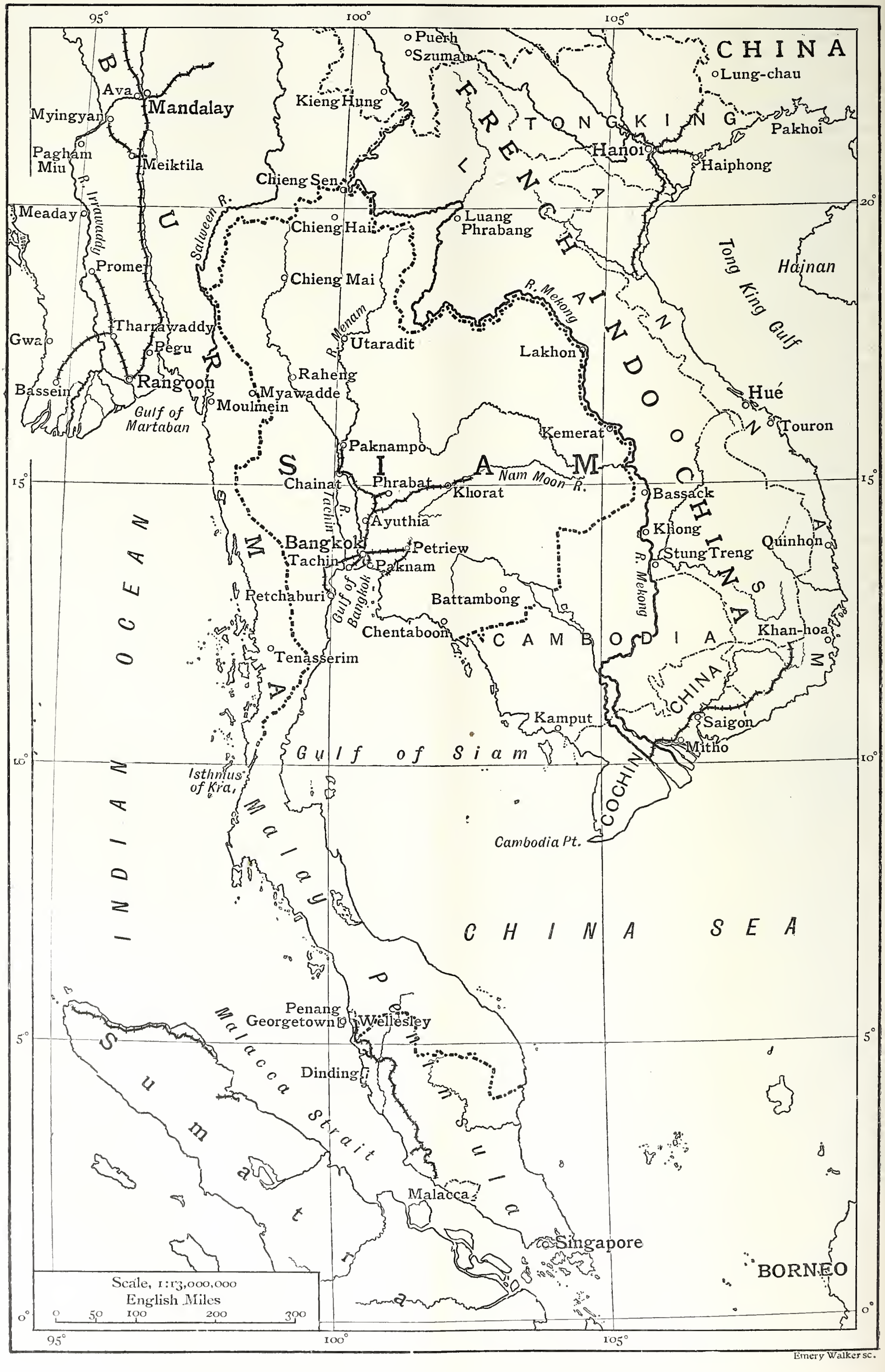
When the King previously came to Europe he left the Queen as Regent with a council of ministers to assist her. This Council was not formed specially for the purpose, but was one of the steps which had already been taken by the King in direction of a constitution, and the training of the men who are to help the country along the lines of progress. It was established only so recently as 1895, as a legislative body whose decrees require the royal signature, but may have the force of law without that formality in the event of any disability of the Crown. It is composed of ministers and nobles to the number of about 50. During her period of regency the Queen became more prominent than any woman before in the country, and won golden opinions for her ability both from her own people and the European residents.

One example of her power of initiative will suffice. A severe epidemic of rinderpest had

so devastated some parts of the country that there were no buffaloes left, and without these it was impossible for the paddy farmers to work their fields. The Queen, realising the seriousness of the situation, sent out commissioners to ascertain what animals were available in parts of the country which had escaped the disease, and to buy up as many as possible. Fortunately large numbers could be had down the coast, and these were bought up and shipped to Bangkok, the Queen herself financing the whole operation. They were sold to the farmers at what they could afford to pay for them, and it is satisfactory to be able to add that, while Her Majesty does not appear to have made any profit on the transaction, she at any rate was able to strike a balance. The moral effect of such an action on her part, however, was more important than the purely financial aspect. No wonder that one of the features of the rejoicings on the King's return was the distribution of commemorative medals bearing the faces of the King and Queen—an acknowledgement of the place of women in the world unique for an Asiatic nation.

Last year the King left the regency in the hands of the Crown Prince, Prince Vajiravudh. This young man, who was born in 1880, has been educated in England, and left this country only a couple of years ago. He was in England at the time of his proclamation in 1895—due to the death of his half-brother, the then Crown Prince—and the King very wisely decided that he should remain and finish his education. He has been under private tuition, and subsequently passed to Eton, Oxford, and Sandhurst. He has shown some literary ability, having written a book on the wars of the Polish succession. I had some conversation with him just before he left for Siam, and was struck, as no one could fail to be, by his marked intelligence, and frank—may it be said, English—demeanour. At any rate, since the whole of his training has been in this country, whither he came at a time when there was no probability of the high honour for which he was destined, we may rest assured that he will be disposed to follow in the progressive footsteps of his royal father, and to pursue the friendly policy to this country which has always characterised the Siamese Government, even before the days when, in 1872, the present King is said to have been so struck by the advantages of our administration of India, which he had just been visiting, that he sought to put his country under our protection on a similar footing to that of the native States of India. When it should come to the Prince's turn to handle the affairs of his country, he will find much has been done to remove his father's chief difficulty. Education has been very actively encouraged, and King's Scholarships have been founded entitling the winners of them to a thorough education in Europe. A new generation is thus growing up with more liberal ideas than those of the past, and with abilities that will enable it to give effect to them; and now that the outstanding disputes with France have been happily concluded, there should be a very bright future for these "free people," who may yet, on a smaller scale, emulate in some way the Japanese in their entrance into the family of nations.

Wanting within his country the material for a sound administration, the King has never hesitated to seek the assistance of capable Europeans, and there can be no two opinions as to the wisdom of this step, even if inexperience has led to occasional mistakes. For instance, when the Government decided upon the construction of the first railway—from Bangkok to Korat—the usual plan was adopted of advertising for tenders. Also, as usual, the tenders from different nationalities were backed up by considerable diplomatic pressure. Accordingly, when an Englishman secured the contract, a sop was offered to Germany in the appointment of Germans to organise the railway department. Friction was inevitable, and a long series of disputes resulted in foreclosing of the contract, and expensive arbitration proceedings which ended in a heavy fine being paid by the Government. It has followed, from the appointment of foreigners as the chiefs of departments, that the departmental staffs have to a large extent become of the same nationality, with Siamese or Chinese in the subordinate positions. Thus the navy is under Danish tutelage; the army Italian; posts and telegraphs German; railways German; judiciary Belgian; finance, police, surveys, forests, and public instruction British. The finance department was one of the latest to be taken in hand thoroughly, under officials lent by the British Government. So efficiently has this work been done, first by Mr. Mitchell-Innes and then by Mr. Rivett-Carnac, that Siam has been able to float loans in the European market for the further extension of its railways. Waste has been stopped in many departments as a result of the rigid tightening of the purse strings, and in this


CHINA
Lung-chau
Puerh
Szumao
Kieng Hung
Ava
Mandalay
Myingyan
Pagham Miu
Meiktila
BURMA
R. Irrawaddy
Meaday
Prome
Tharrawaddy
Gwa
Pegu
Bassein
Rangoon
Gulf of Martaban
Moulmein
Myawadde
Salween R.
Chieng Sen
Chieng Hai
Chieng Mai
R. Menam
Utaradit
Raheng
Paknampo
SIAM
Chainat
Phrabat
Khorat
Nam Moon R.
Ayuthia
R. Tachin
Bangkok
Tachin
Petriew
Paknam
Petchaburi
Gulf of Bangkok
Battambong
Chentaboon
Tenasserim
CAMBODIA
Kamput
Gulf of Siam
Isthmus of Kra
FRENCH INDO CHINA
TONGKING
Hanoi
Haiphong
Pakhoi
Luang Phrabang
R. Mekong
Lakhon
Kemerat
Bassack
Khong
Stung Treng
Quinhon
Khan-hoa
ANNAM
Hué
Touron
Tong King Gulf
Hainan
COCHIN CHINA
Saigon
Mitho
Cambodia Pt.
INDIAN OCEAN
CHINA SEA
Malay Peninsula
Penang
Georgetown
Wellesley
Dinding
Malacca Strait
Malacca
Singapore
Sumatra
BORNEO
Scale, 1:13,000,000
English Miles
0 50 100 200 300
95°
100°
105°
20°
15°
10°
5°
0°
Emery Walker sc.

way we may be able to claim that whatever nationalities control the other departments, they are all finally controlled by the British official who holds the important post of Financial Adviser.

I am often asked whether Siam is not a French dependency. The last statement should in itself serve to destroy any such impression. As a matter of fact there is no nation that stands so high in the good books of the Siamese as Englishmen. English is the *lingua franca* of the country, and business is conducted in that language by all the merchants, no matter what the flag under which they trade. Government notifications are published in Siamese and English—sometimes in Chinese also, where they affect the very large Chinese populations, and all court functions in which the "Farangs," or foreigners, participate, are conducted in English. The usual address of congratulation from the foreign representatives on such occasions as the King's birthday, or any public function, is always read in English, even though the doyen of the diplomatic corps at the time may be a representative of either of the other countries. The natives speak our language with remarkable purity, and I have heard English Eurasians whose accent and pronunciation were far less pure than that of the average Siamese who speaks English. The spread of education in the country has produced changes in linguistic as well as in other matters, but as recently as ten years ago there was only one Siamese in the country who could speak two European languages, and he spoke English and French. He was then the Siamese editor of the bi-lingual daily paper for the English side of which I was responsible, but is now governor of one of the provinces of the interior.

The chief products of Siam are rice and teak. The former represents 77 per cent., and the latter 13 per cent. of the exports, leaving a paltry 10 per cent. for everything else. A glance at a good map will explain this. If we leave out of consideration the Khorat plain, which is as yet undeveloped, Siam consists mainly of two sections—the hill country where the teak grows; and the low country around Bangkok. Commercially, it is a country of but one river, the Menam, which floats down the teak from the hills; and also brings down from the same source, suspended in its muddy waters, the food best suited to the rice plant. In fact it may be said that the whole of the level plains around Bangkok are the creation of the Menam. Every year that river overflows its banks to flood the country with its rich muddy water. At the mouth of the river is a bar that serves the purpose of keeping the waters back, thus allowing time for the mud to be deposited. On either side of the mouth are mangrove swamps which also assist in the process of deposition. We can thus imagine a time, centuries ago, when the bar and the mangrove were where Bangkok now stands, and a yet further time, in the centuries to come, when the Gulf of Bangkok shall have grown yet smaller, and a busy city be built upon the site of the bar of to-day—that is if man allows Nature to have her way. In Bangkok, to-day, the best foundation for building is on the surface. Every foot you dig into the soil the more soft and yielding it becomes, and I have heard of a bore thirty feet deep passing all the time through this soft river deposit only to come at last upon the sand of the old sea bed. A good deal has been done in the way of irrigation to extend the area fed by the river, and canals intersect the country in all directions. One result of this configuration of the country is that it is a country of one port. Nearly all the foreign trade passes through Bangkok, a fact which certainly has the merit of simplifying the work of the statistician. But Chieng-mai—often spoken of as the northern capital—is growing in importance, and as the trade from the north naturally passes through Burmah, this is a matter upon which we, as the masters of Burmah, may congratulate ourselves. The main routes for this trade are down the Salween to Moulmein, or down the Menam to Raheng, which is about 50 miles from Myawadde, on the Burmah frontier, and then overland to Moulmein. This latter route is increasing in popularity, and is likely to do so still more rapidly when the Burmese railway extension to the frontier at this point is completed.

One of the most interesting ceremonies of the Siamese year is held in connection with the rice industry. It is a ceremony which serves both as a blessing of the seed, and a means of forecasting the outlook for the season. This is the ploughing festival held in April. The Minister for Agriculture goes out into a field which has been selected for the purpose, and gaily decorated with booths and flags. He goes in full state, wearing regal robes and crown, and his first care is to go into a booth where three cloths of differing lengths have been laid out for his selection. There is nothing in their appearance to guide him, and he picks one up at haphazard. This he

puts on, and goes into the open for the next step in the proceedings. Immediately he appears all eyes are on him to see which cloth he has chosen. Should it reach down to his feet the rice farmers' hearts will fall as low also, for they see in that an indication that the year will be a very dry one. Should it fall only to his knees this is taken to indicate the opposite extreme. What everyone prefers is that it should be of a medium length. The Minister then takes hold of a ceremonial plough with an exceedingly long pole, and guides it three times round the field, a couple of cream-coloured bullocks pulling it. He makes no attempt to drive the plough down into the land if it be at all hard, as when I photographed it; while if it be wet we may be all standing, as on another occasion when I attended, up to our ankles in warm soft mud that required no ploughing. A couple of very old women next step forward with baskets of seed rice which has been consecrated by the priests, and the Minister proceeds to scatter this abroad over the field. The by-standers at once scramble for as much of it as they can secure, since they believe the addition of it to their own seed will render it more fruitful. The bullocks are then led off to be regaled with a selection of grass and seeds, each put out in little baskets for the animals to take their choice from. It is gathered from which they select first what is likely to be the most fruitful crop of the year. After this ceremony the farmers proceed with their own ploughing. The seed is not scattered on the fields as we do with corn, but is sown in a nursery, from which the young plants are taken when sufficiently grown, and planted out in the fields in six inches or more of water. By the time the grain is ripe the water will have subsided again, and the crop is cut and conveyed—often on sledges—to the threshing ground. This is merely a good-sized plot of ground trodden down hard, and the threshing is done by driving buffaloes over the rice until the grain is trodden out from the straw. The latter is heaped up for eventual burning, and the grain collected for market. The milling of the rice in Bangkok is a considerable industry, in which a good deal of capital is sunk, and a large number of English engineers are employed; but most of the mills are either owned by Chinese, or have been financed by Siamese princes or nobles.

There are stated to be 60 rice mills in Siam, of which four (three Siamese and one French) are at Patriew, and one (French) at Singora. The other 55 are in and around Bangkok; 26 are Siamese, 16 British, 10 French, and 3 German. It may be interesting to add that the boilers at these mills are so constructed that the furnaces are able to use the husk of the rice as fuel. In fact the electricity works also, as well as other steam-raising plants, depend on this husk and the sawdust from the teak saw-mills for their main supply of cheap fuel. I have seen some of these furnaces so constructed that as the husk is fed in and burnt it falls into a running stream of water below that takes the ashes straight out to the river. Whether the Government still permits this menace to future navigation I do not know, but how real a danger it must be can be gathered from the huge mounds outside some of the oldest established mills. Here the husk has been piled up for years and burnt away to ash. I have often thought these heaps of refuse may some day find a use. The carbon constituents have entirely burnt away, and all that remains is a pale pink earth which would probably be found on analysis to be a fairly pure silica. If so it might prove a cheap source of supply for a possible earthenware industry. I have heard of its being used for tooth-powder and also as a basis for disinfectant powder, for which, however, in view of its insolubility, it seems hardly suited.

The exports of rice are gradually increasing, and should continue to do so as the railways open up the country and irrigation extends the area available for the growing of paddy. In fact, in ten years the export has practically doubled, since, while 456,916 tons were exported in 1896, the figures for 1906 are 917,682 tons. The distribution of this large export is stated to be as follows:—

Country.	1905.		1906.	
	tons.	per cent.	tons.	per. cent.
Singapore	317,974	38½	335,755	36½
Hong Kong ..	387,900	47½	428,994	47
Germany	20,115	2½	38,259	4
Others	94,875	11½	114,674	12½

Much of the rice sent to Singapore passes on to Europe and to India, and a feature of the Siamese rice trade is the growing favour of the rice in the European market. Most of that shipped direct to Germany is used in brewing and the manufacture of starch.

The teak trade is mainly in British hands. The tree grows in the hills, but not at all after the manner that we should imagine from

experience of our own forests. With us an oak forest would mean an area practically covered with oaks. A teak forest is an area within which the teak grows, surrounded by a very large proportion of trees of other species. The tree has therefore to be looked for. When found it has a girdle cut round it through the bark. This stops the further circulation of the sap, and in the course of about three years the tree dies. It is then cut down, trimmed, and worked out by elephants to the banks of the streams. When the rains come, if they be heavy enough, it gets out into the main river and so down to Bangkok. If they fail to float the log, it remains until another year. Altogether it takes anything from four years upward from the first girdling of the tree in the forest to its delivery in Bangkok for export—and all the time more or less money is being spent upon it.

The logs are marked by hammers, bearing on their faces the distinguishing marks of their owners, and make their way promiscuously through the rapids and over the shallows of the river to Ban Na, where they are sorted out and made into rafts, their next stoppage being at Chainat, where the Government duty is collected. During the passage down the river, there is a loss of from 2 to 5 per cent. of the logs—a proportion representing the number that are intercepted, the hammer-mark obliterated, and then taken down to Bangkok by the thieves, and sold, possibly, to the original owners. In the course of some legal proceedings in Bangkok, at which I was present, some interesting particulars were given as to the time it takes to get logs from the different forests, into Bangkok, and the money that has to be spent on each log. From these I have compiled the following Table, in which it is assumed that the trees have already been cut down, and the logs placed in the respective rivers ready for floating down in March, 1908:—

	Arrive Bangkok.		Cost, rupees.
Main Rivers—			
Below Raheng....	October, 1908	..	5 to 6
,, Chiengmai..	March, 1909	..	11 ,, 13
,, Chiengdow..	October, 1910	..	13 ,, 15
Lakon river	March, 1910	..	12 ,, 14
Me Yom	March, 1909	..	15
Brooks and Creeks—			
Me Haht	March, 1909	..	14
Me Lee..........	,, 1909	..	13 ,, 15
Me Wahn	,, 1909	..	13 ,, 15
Me Kahn........	,, 1909	..	13 ,, 15
Me Tah	,, 1910	..	13 ,, 15
Me Lim & Tang ..	October, 1911	..	13 ,, 15
Me Tahn........	?	..	18 ,, 20

The cost is probably greater at the present time, as the tendency of all prices in Siam is upwards, while the period of floating is entirely dependent upon the rainfall.

It will be noticed that in this Table the cost is given in rupees. Ten years ago the Indian rupee was the only coin circulating in Northern Siam, and it is still in use there. But gradually the Siamese tical is taking its place. This is a silver coin worth 60 cents. of a Straits dollar, while the intrinsic value of the rupee is but 50 cents. Gradually the tical is being placed on a stable gold basis, and the exchange value at the beginning of December was 1s. $5\frac{1}{16}$d., the Government rate of exchange being 13 ticals to the pound sterling. Originally the tical was made somewhat like a bullet. I have heard no explanation of this curious shape, but I fancy that as cowry shells at one time constituted the currency of the country, the Siamese, when coins of greater value were needed, naturally imitated the shells in metal. The tical is now made like ordinary coins, and the bullet-shaped one is going out of use, while the coins of smaller denominations can only be obtained in the bullet shape as curios. There is another curious shaped coin in circulation up-country, made of bronze, and exactly like a flat-bottomed boat, hollow inside, with well-turned up prow.

The necessity for keeping up a supply of elephants for work in the forests affords the Bangkok resident an excuse for an annual holiday, and a few days full of interesting incident. The herds that roam about up-country are driven into the ancient kraal at Ayuthia, a very substantially walled-in space within which the animals are driven by men on tame elephants for the purpose of selecting the most promising young ones. The men have long poles with nooses of raw hide at the end, and when an animal is selected the noose is slipped over one of its hind legs, and the end dropped. Attendants are ready to slip in from behind the solid log fence within the kraal, to pick up the rope, and fasten it to pegs placed for the purpose. When several have been thus secured, the herd is let out on to the open plain, where they are kept from wandering too far by a cordon of tame elephants. Here the noosing is repeated, but with far more risk to those engaged, and to the large crowd of lookers-on. At times an elephant will break away, when the people in the vicinity have to scatter to places of safety, although frequently some unfortunate is overtaken and crushed to death. Often the mother

of a captured youngster will do her best to effect a rescue, but the raw hide of which the ropes are made is unbreakable, and she is eventually driven off. The captives also make strong but useless efforts to escape, and often show fight when the tamed animals come up to lead them off. But ultimately they become as docile as those who assisted in their capture, and may be seen quietly doing their intelligent work in the forests.

Unfortunately the forests have been overworked in the past, and the supply of Siamese teak is likely to fall off for a few years at least. The last two seasons have been very good floating ones, and a lot of accumulations in the creeks were floated out, so that there is now no reserve to look forward to to keep up the average, and with a reduction in the number of trees available, there is sure to be a falling-off in supplies. The Government has taken a wise step in getting the loan of several of our Burmese Forest Department officials, and with regulations for the planting of young trees for every tree cut down, and the prohibiting of the felling of trees below a given girth, we may look forward eventually to a restocking of forests now worked out. In this matter we are more interested than any other nation except the Siamese themselves, as the bulk of the teak trade is in our hands. Nearly all the teak exported, too, goes to British possessions. Here are the figures as given in the Consular reports for the past two years :—

Destination of teak exported.	Quantity in tons. 1905.	1906.
India	66,788	67,027
Hongkong	9,848	9,033
United Kingdom	5,577	6,270
Azores	2,629	4,671
Singapore	4,185	2,835
French Possessions	2,592	1,812
Italy	—	1,538
Germany	1,493	1,213
China	—	391
Denmark	1,033	246
Penang	—	63
Australia	—	42
Egypt	—	16
Europe	2,375	1,680
Total	96,520	96,837

It must not be assumed, because teak bulks largely in the exports, that this is the only wood Siam produces. Ebony appears in the Government return for last year at 26,588 ticals, and rosewood at 114,403. Other less known woods are padoo, agilla, and sapan, which together were worth over 132,000 ticals. There are also many forest products such as gums and resins, while last year rubber appeared for, I believe, the first time, the quantity exported being 52 tons, valued at £12,214. This is an article likely to increase in quantity, as there is now a Rubber Co. whose prospects can be gauged from the fact that its £2 shares were last December quoted in Bangkok at about double that price. Certainly the kind of rubber plant with which are all familiar as a decorative pot plant in this country flourishes in Bangkok prolifically, and I had a fine specimen in my garden which grew rapidly from a small cutting. I also found a creeper growing wild, the pods of which gave off a plentiful flow of juice which dried to a very rubber-like substance. I collected a little of it, but rubber was not then so much before the world as it is now, and so I never followed it up as one might be disposed to do in the present state of the rubber market.

Passing now to the trade of Siam as a whole, the value of the exports in 1906 was £7,082,141, of which the great bulk, that is to say, £5,972,669 went to British possessions. The imports were £4,866,849, of which £3,811,668 came from British possessions. The full figures are as follow :—

ANALYSIS OF BANGKOK TRADE FOR 1906.

Country.	Exports.	Imports.
British.	£	£
Singapore	2,659,382	1,583,147
Hong Kong	2,706,061	1,169,937
United Kingdom	94,083	773,127
India and Burmah	511,235	278,713
Malaya	245	4,351
Penang	1,148	78
Australia	545	2,315
Total British	£5,972,699	£3,811,668
Non-British.		
Germany	365,559	300,426
French Possessions	55,977	105,292
Dutch ,,	73,602	60,220
China	5,151	242,286
Japan	263	26,944
Other Countries	708,890	320,013
Grand Total	£7,182,141	£4,866,849

These are the figures usually quoted in works of reference as representing the trade of Siam. They do not, however, tell the whole story. A good deal of trade crosses the frontier at various points such, for instance, as that for

which Khorat is the centre. The Khorat trade comes from as far afield as Yunnan, and there is no record of the movements of the caravans on that side, nor of the merchandise they carry to and fro. The trade of Northern Siam, however, is better looked after, and so it is possible to give the following Table representing the total external trade of Siam through its two chief centres at Bangkok and Chiengmai :—

TOTAL TRADE OF BANGKOK AND CHIENGMAI FOR 1905 AND 1906.

To or from.	Exports. 1905.	Exports. 1906.	Imports. 1905.	Imports. 1906.
	£	£	£	£
Bangkok... ...	5,989,100	7,082,141	3,993,635	4,866,849
North Siam ...	207,574	215,758	152,745	159,151
via Raheng	6,221	11,687	5,487	15,993
Total	6,202,895	7,309,586	4,151,867	5,041,993

The predominance of the English language to which I have already alluded is reflected in the great preponderance of trade. Yet I am sorry to have to add that in this distinctly friendly neutral market we are not holding our own proportionately with the past. In 1905 we were able to boast that 86 per cent. of the export trade and 79 per cent. of the import were with Great Britain or her colonies. The proportions for 1906 are 84·3 per cent. and 76·3 per cent. The proportion is still a large one, and is bound to remain so, because so much of the freight is transhipped at Singapore or Hong Kong, and therefore appears in the returns as received from or consigned to those ports. But, inasmuch as they are both merely places for the collection and distribution of merchandise from all parts of the world, we are not justified in regarding the commerce credited to them as belonging altogether to the empire.

The total of Bangkok's imports, £4,866,849, is made up of a large variety of articles, first among which stand cotton goods and cotton yarn — £1,024,394. Then treasure represents £674,431; steel, iron, and machinery, £317,406; gunny bags (for packing rice for export), £223,877; sugar, £219,784; and provisions of all kinds, £276,378. Other articles that exceed £100,000 in value are hardware and cutlery and silk goods. The consular report for last year gives an interesting comparison of the shares of the chief importing nations in the two chief imports—cotton goods and iron—which I have condensed as follows :—

Country.	Cotton. 1903	Cotton. 1904	Cotton. 1905	Cotton. 1906	Iron. 1903	Iron. 1904	Iron. 1905	Iron. 1996
United Kingdom	$22\frac{1}{4}$	$33\frac{3}{4}$	$35\frac{1}{4}$	$32\frac{1}{2}$	$43\frac{1}{2}$	$57\frac{3}{4}$	57	$50\frac{1}{4}$
British Possessions..............	63	47	51	$55\frac{1}{2}$	32	17	16	$16\frac{1}{2}$
Germany	$4\frac{1}{4}$	$6\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{1}{4}$	12	$11\frac{1}{4}$	7	$15\frac{3}{4}$
Switzerland......	$7\frac{1}{4}$	$9\frac{3}{4}$	$6\frac{1}{4}$	4	—	—	—	—
Netherlands ...	$2\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$3\frac{1}{4}$	—	—	—	—
Belgium	—	—	—	—	—	$8\frac{1}{4}$	$5\frac{1}{2}$	$6\frac{1}{2}$
United States ...	—	—	—	—	3	$2\frac{1}{2}$	5	$5\frac{1}{2}$
Others	$\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$9\frac{1}{2}$	$3\frac{1}{4}$	$9\frac{1}{2}$	$5\frac{1}{2}$

When we turn to the shipping, we find a far worse state of affairs. In 1898, we were able to claim 76 per cent. of the vessels, and 78 per cent. of the tonnage using the port of Bangkok. Unfortunately, the bulk of these vessels were in the control of the Holt line, who sold them to the Germans, regardless of the prestige of our flag. The relationship of this line with another owned in Hongkong —the Scottish Oriental—were so close, that when one fleet went, the other also was transferred, and to-day we can only claim just under 13 per cent. of the vessels, as against 14 per cent. last year; while the Germans have 51 per cent., against 48 per cent. last year. Indeed, we are beaten by the Norwegians also, both in the number and the tonnage of the vessels. It has been said that the transfer was made because the line could not be made to pay. As the figures proved the line to have carried the bulk and the most valuable of the cargoes, this assertion can hardly be taken seriously. What effect this transfer of shipping to a rival flag will have upon our share in the total trade of the country has yet to be seen, but it cannot fail to operate prejudicially, and may be the deciding factor in producing the drop in our proportion of that trade to which I have just been alluding.

Communications in Siam are capable of great improvement. The distance between Bangkok and Chiengmai, the two business centres of Siam, is about 450 miles—more or less according to the route taken—and it takes three weeks for the mails to pass from one to the other! The native methods of travelling are two—a heavily-built springless cart pulled by buffaloes, and the more comfortable boat, on which it is possible, when the season is favourable, to make the whole journey from Bangkok to Chiengmai by river. There is also a service of motor boats on the lower

reaches of the river, which is so entensively used by the natives that the 100 tical shares or the company are quoted at 175 ticals. But the Government now fully realises the value of railways, and their construction is being pushed forward in several directions, both by State and private enterprise. The first railway to be constructed was that from Bangkok to Paknam, a distance of seventeen miles, which was opened in 1893. This is the property of a company, and is doing so well that its shares, issued for 80 ticals, were selling at 190 at the end of November last. In 1892 the King cut the first sod for the first Government railway, from Bangkok to Khorat. This was opened as far as Ayuthia in March, 1897, by the King and Queen driving the spikes of the connecting length of rail. The full length of 164 miles was opened in November of 1900. This line as far as Ayuthia will form part of what is destined to be the main trunk line of Siam, running through the heart of the country to the far north, with branch lines east and west. The first section of the northern extension to Lopburi was opened in 1901, and in November, 1905, a further extension to Paknam Poh was opened. Work is steadily progressing on the next two sections of this line to Pitsanulok and hence to Utaradit, and it was hoped to open these at the end of last year, but it was only possible to do so as far as Pitsanulok.

Another line starting from Bangkok runs eastward to Patriew, a distance of 39 miles, and yet another westward to Tachin, with eventual extension to Ratburi and Petchaburi, so bringing the capital into closer touch with the Siamese Malayan States. In connection with the main railway a tram line has been constructed from near Ayuthia to Phra Bat, the centre of religious pilgrimages by reason of a reputed footprint of Buddha on one of the hills there. The Bangkok Tramway Company has a system six miles long, and as this runs entirely through Bangkok itself it gives a fair idea of the size of the Siamese capital. The shares of this company, issued at 100 ticals, were quoted in December at 185. The total of railways constructed and constructing for the Government is about 540 miles, with a further 67 miles by private enterprise. Fortunately the Government is receiving the best encouragement to go forward in its railway policy, in the shape of a clear return of about 5 per cent. on the capital outlay so far incurred, in addition to the increased revenue in Customs' duties, &c., due to the growth of trade.

With so much being done by the Siamese Government itself, and by concessionaires of all nationalities, to open up the interior and develop the natural resources of the country, Siam seems to offer bright prospects for the investor. During the last ten years a number of companies have sprung into being, and appear to be prospering, while the number of Europeans in the country has enormously increased. One indication of the prosperity of the country is revealed in a remark in a Bangkok paper of a few months back that a plot of land bought ten years ago for 300 ticals now commanded as many thousands, with the note that this was not peculiar to any special site, but was characteristic of all parts of Bangkok. I had intended to lay before you a detailed Table of the industrial companies in Bangkok, with their dividends, share issue, present share value, and so forth, but since I have been asked to read this paper at an earlier date than originally intended, I am not able to do this, and am obliged to take the following Table from the recent issue of a Bangkok paper, as supplied to it by Mr. K. W. Nordmann, a local share broker, giving the values of the leading shares at the beginning of December last, when the Government rate of exchange was 13 ticals to the pound sterling :—

Company.	Par value.	Present quotation.
Siam Electricity Co., Ltd., Shares......	£10	Tcs. 520 (buyers)
Bangkok Manufacturing Co., Ltd., Shares	Tcs. 100	Tcs. 125 (buyers)
Bangkok Dock Co., Ltd.	Tcs. 166⅔	Tcs. 315 (sellers)
Howarth Erskine Ld.	$100	S'pore $160 (buyers)
Meklong Railway Co., Ltd.	Tcs. 100	Tcs. 127 (last sales)
do.	Tcs. 100	par plus int. (buyers)
Paknam Railway Co. Ltd.	Tcs. 80	Tcs. 190 (buyers)
Siamese Tramway Co., Ltd., Shares	Tcs. 100	Tcs. 195 (last sales)
Do. Deb.	Tcs. 100	par plus int. (buyers)
Do. Share Warrants..	Tcs. 100	par plus int. (buyers)
Siam Steam Packet Co., Ltd., Shares	Tcs. 50	Tcs. 112 (sellers)
Prabad Tramway Co. Ltd.	Tcs. 100	Tcs. 80 (nominal)
Langsuan Tin Mines Co., Ltd.	£1	Tcs. 65 (sellers)
Siam Commercial Bank Co. Ltd. ..	Tcs. 1000	Tcs. 1550 (sellers)
Menam Motor Boat Co.	Tcs. 100	Tcs. 175 (last sales)
Jendarata Rubber Co. Shares	£2 paid	Tcs. 50 (nominal)

If my correspondent send me all the details I have asked for, the Table will be a very interesting one, and possibly I may be permitted to supply it for publication in a later issue of the Society's *Journal*.

With regard to the Europeans in Siam, the number has very nearly, if not quite, doubled in ten years. I have made an analysis of the names in the Bangkok directories of 1897 and 1907, and so obtained an approximate estimate of the numbers. There are two elements of error in such a comparison. First, Eurasians are treated as foreigners in the directory, and, if of any standing, appear in the same columns with Europeans; and as many of them bear European names it is impossible to distinguish them. The other opening for error is in the number of British subjects, since Americans also bear English names. I have reduced the latter element as far as possible from my knowledge of the people named, but even then the following figures can only be offered as approximately correct:—

	1897.		1907.
Foreigners in Government employ	156	....	295
All resident foreigners ..	579	....	944*
Of these British number..	172	....	331

It should be noted that, whereas ten years ago the number of foreign ladies in Siam was extremely small, their number has so increased in the interval that the directory adds a special list for their benefit, from which it appears that there are now 239 in the country. The total population of Siam has long been the subject of the wildest guesses, but there has recently been a partial census, on the basis of which the number has been estimated at nearly seven millions. The total number of British subjects of all races registered at the consulates is about 5,000, but there are many who neglect to renew, especially among our Asiatic subjects, and women and children are not counted, and we possibly have as many as 20,000 British subjects living in Siam at the present time.

As a place of European residence Bangkok bears a very bad reputation with all people in the Far East who have not been there. Fever is to be experienced, as in other tropical places, but there are worse spots, and people who suffered from it in Singapore have been known to pass unscathed in Bangkok. Cholera is endemic, and rarely epidemic. Quite possibly cases of severe diarrhœa and ptomaine poisoning are occasionally attributed to cholera. The climate is at times trying, but in December, when the swallows come down from the north on the wings of the northerly breezes, the day is more bearable than some summers in England, and the evenings are cold to the scantily-clad native, while hot grog is not unknown in the home of the European; and it is possible to take a brisk walk even as late as nine o'clock in the morning without turning a hair. One expects heat in a country in the tropics, where twice in the year the sun shines perpendicularly, and one's shadow shrinks to the minimum. But after four years of Bangkok weather I am bound to confess that I prefer it to the two years I had of Colombo, or the briefer samples of Singapore.

The following Table gives the official observation of temperature and rainfall for Bangkok for each month of the year 1906, with the mean temperature and total rainfall for the two previous years:—

	Temperature (Fahr.) Mean.	Max.	Min.	Rain. Inches.
	Deg.	Deg.	Deg.	
January........	83·9	100	65	0.025
February	85·5	104	65	
March	85·4	100	64	
April..........	90·3	106	72	0·075
May	88·8	106	74	5·1
June	86·1	99	74	5·38
July	85·2	100	72	7·93
August	85·1	99	74	6·91
September	84·7	98	73	14·72
October........	82·4	100	64	4·58
November......	79·5	98	56	1·23
December	79·2	100	57	
1906	84.6	..	..	45·95
1905	84·7	..	..	60·11
1904	81·6	..	..	59·48

The total number of rainy days in the year was only 110, even when those are included upon which only a few drops fell. But the worst days would not compare with our ordinary wet days. Very rarely is the sun overcast all day. The rain generally comes down in torrents for a short time, and then the clouds pass over and the sun comes out again, until the next squall brings up a further deluge.

During part of the time I kept the records which were sent to the Meteorological Society, and on turning back to my notes, I find that the highest temperature I observed was

* Plus 239 ladies = 1183.

103° Fahr., and the lowest 57·5°. The maximum was in April, but it was always followed by a drop to about 75° at night, very often with a breeze that increased the apparent difference. This wind, in fact, prevailing all day, was a mitigation of the day temperature that was welcome in its constancy. The showers of later April brought lower day temperatures, but the drier heat of March was less uncomfortable. The above Table gives the maximum for 1906 as 106° in April and May, and the minimum 56° in November. The rainy months are May to October, September providing most of the rainfall. This is an important matter to residents, as in the absence of a water supply we have to depend upon that from the clouds. Large tanks, or a room full of huge water jars, form part of the furnishing of every household, and these have to be filled up by the end of September, if we are to look forward with equanimity to the coming six months of almost absolute drought. These jars, which are suggestive of those associated with the painful deaths of the Forty Thieves, are, unfortunately, unglazed, and very often one finds many of them run dry, and all much depleted by evaporation, by the time the rains come round again. If the spring rains be delayed, householders pass through a very anxious time. As a rule there is no road without a canal by its side, out of which has been dug the material to raise the road above storm level. There is thus plenty of water near every house. But these canals are tidal, and at the end of the dry season, when the fresh water has nearly run off, the salt from the sea makes the water too brackish for use, and it is then that there is most sickness among the natives. At other times the water from the canals is useful for cooking purposes and so forth, being clarified by the simple process of filling a jar with it and swilling it round with a little alum. But as the native houses are often built on the banks, and drains run into them, these canals are not desirable as sources of a domestic water supply.

Social life is very pleasant. The Siamese are excellent entertainers and there is always something going on. There are quaint and intensely interesting religious functions, festivals, traditional customs, and so forth ; cremations, which are times of merriment rather than gloom ; Court functions, and the annual kraaling of elephants already mentioned. Then there are the national festivals of the European nations, which are usually observed by all the members of such a cosmopolitan community. In addition there are the new years. The Siamese have two, the civil and the ecclesiastical, and make a holiday of both. There is the European, for the keeping of which the Scotch are most noted ; and the Chinese. Sports of the gymkhana order have been instituted, and the King has given a very fine gold cup to be raced for annually by Siamese ponies. Each evening, except on Wan P'ra, the Buddhist Sabbath, the military band plays near the palace, thus providing a sort of daily rendezvous and an excuse for a drive when others fail.

Rents have about doubled in Bangkok in the past ten years ; but a far more serious matter is the eternal servant question. Wages have gone up enormously, while the Chinese, who do all the domestic work, have combined into a sort of domestic servants' union. A friend writing recently told me of a lady who was for a time entirely without servants through the operation of this union. It appears that her first boy left, and she engaged another. The second boy was offended because he was not promoted, and went to the Union. All the servants were ordered to leave, and before she could get them back she had to promote the second boy, and pay a fine to the Union. I had been longing, amid the servant troubles of this country, for the old days in the East, but such a letter as that is calculated to make one content with the troubles we have.

In religion the Siamese are Buddhists. Every village has its watt, or temple, and Bangkok boasts several of great beauty and interest. Chief among them, of course, is the King's temple within the palace enclosure. Most prominent in the landscape, however, is that on the opposite side of the river—watt Chang. Another provides the only hill to break the dead level of the Bangkok plain—a hill, however, which has been laboriously built up of bricks. This is is a representation of the hill at Phra Bat which I have already mentioned as a centre of pilgrimmage, and is intended to serve the purpose of those devotees who for any purpose cannot make the longer journey. In the temple on the top of the hill is a replica of the footprint at Phra Bat. The yellow robes of the monks are familiar sights in the streets, while upon them has rested the obligation to educate the young Siamese. The King is head of the Buddhist church in the country, and must have passed a certain period within the cloister. In fact, it is worthy of note that

he is the last independent Buddhist sovereign in the world, all the other kingdoms of this faith having passed under foreign domination. It was partly for this reason, and partly as an indication of our very friendly relations with the Siamese, that in 1898 the Indian Government sent to the King of Siam some relics of Buddha which had been unearthed in a ruined stupa, or dagoba, on the Nepal frontier. The reception of these in Bangkok was the occasion of some imposing ceremonials and street processions. A characteristic of Buddhist countries is usually their liberality as regards other religions. Siam has long been open to the efforts of Christian missionaries, although very few have taken advantage of the opening. The American Presbyterians have been at work for many years, a medical mission being part of their organisation. The American Bible Society and American Baptists also have each a small agency at work. The Roman Catholics have a well-organised mission, but as the priests are mostly Frenchmen, the troubles with that country have not tended to smooth their way to the hearts of the people. More especially was this noticed when, after the troubles of 1903, the Bishop in charge of the mission permitted himself to be decorated by the French Government in recognition of his services. It has only been in the last few years that an English mission has been started. It is represented even yet by only one priest, supported by the S.P.G., and it is cause for regret that none have yet been sent to assist him in this very promising field. The Europeans of all nationalities, and of all denominations, who are not Roman Catholics, subscribe a stipend for a clergyman of the Anglican Church, who acts as their chaplain. A small church which was used for many years, in a rather out of the way situation, has now been replaced by a larger building on a more suitable site. It may be interesting to add that this church is in the diocese of London; and that when the Bishop of Singapore (only four days distant) came to Bangkok for a confirmation, it was necessary, first of all, to read an authority to do so, sent him by the Bishop of London—about thirty days distant.

One of the peculiarities of European life in Siam is that, excepting the small import duty, no taxes are paid, and no rates. Europeans enjoy all the advantages of extra-territoriality, on the whole without abusing their rights and privileges. The matter is somewhat different, however, when it comes to the Asiatic subjects of European powers. These have the same rights, but do not always use them in the best way. For instance, if a Siamese policeman be in pursuit of a criminal, the man has only to enter the home of a foreign subject to be safe from further pursuit. The officer cannot advance further without violating the flag of the foreigner, unless the householder grants permission. Should he refuse there is no alternative but to go to the Consul concerned and get his authority. This delay would be fatal where the foreigner was in collusion with the criminal. As criminals have themselves sought registration at foreign consulates for the express purpose of abusing their privileges there is no cause for wonder that the Siamese Government is beginning to long for the days when these special privileges shall be abolished. They are undoubtedly a hindrance to the good government of the country in many ways. To quote another example that occurred during the French troubles; the Siamese Government were anxious to carry out a much needed road improvement in the busiest part of the city, but was stopped by a house, which completely blocked the way. This house belonged to a French *protégé* who refused to sell on any terms, and there was no means by which he could be compelled to do so. It is, in fact, stated that his Consul induced him not to sell, for the express purpose of harassing the Government. Little points of this sort help us to understand how very much such nations as the Siamese have given up when granting these extra-territorial rights, and although we might not as yet care to forego them in respect of Europeans, the question might be considered in regard to Asiatic subjects.

DISCUSSION.

In reply to a question, Mr. HILLMAN stated that the *Siam Observer* was still published, but it was a considerably larger paper than when he had charge of it.

The CHAIRMAN (Sir Steuart Colvin Bayley, K.C.S.I., C.I.E.), in proposing a hearty vote of thanks to the author for his interesting and instructive paper, said he could claim no personal knowledge of Siam, but it had been his unfortunate duty for certain years of his life to study the correspondence concerning the Franco-Siamese question, which Mr. Hillman had wisely omitted from his paper. As all was now peace and amity, he would not further allude to it beyond saying that the result of the long contest could be seen by comparing a large scale map of 15 years ago with a map of the present day.

With regard to the question of extra territoriality, he could fully endorse the remarks which had been made, that giving the privileges of extra territoriality to the Oriental subjects of different European States was a weakening of the power of the central government, which had no compensating advantages. So far as the question concerned us it was from the side of India, because there were very large numbers of Burmese who were British subjects, some of whom had been living in Siam merely for a time, while others had lived there for two or three generations. It was not the policy of the Government of India, however, to push or even to encourage the claims of the rights of British subjects by the Orientals who had settled in Siam, who, for the most part, were people of the Shan States, with an administration not conspicuously in advance of that which they met with in Siam; and the English officials always felt it was a weakening of the local government to encourage that claim of extra-territoriality. Without saying that British help would not be given to British subjects, they insisted upon them taking the considerable amount of trouble involved in registering their names if they wanted it, with the result that while in serious cases it was claimed, in the majority it passed *sub silentio*. He had been very much interested in the author's remarks with regard to the King of Siam. He happened to be in Calcutta at the end of his Majesty's visit to India, and recollected certain doubts among the officials of the Foreign Office as to how he was to be received. The Indian Foreign Office was, of course, accustomed to receiving the Indian native chiefs and princes, and definite rules were laid down for that purpose; but when it came to recieving an Oriental monarch precedents were rare. It ended in Lord Mayo saying that if our visitor was a king, he must be received as a king, whatever his age and whatever he governed; and that settled the question. He recollected that Lord Mayo was very much struck at the time with the king's intelligence; and, later on, he (the Chairman) was personally instrumental, merely as a junior official, in sending to Siam, in 1872, at the request of the Siamese Government, a slip of the sacred Bo tree of Bodh-Gaya, under which Gautama Buddha was said to have attained knowledge. Another point which had interested him in the paper, was the question of the education which was being given to the royal princes and nobles who were likely to have power in the future. In India, that had been found rather a dangerous experiment. It had answered very well in some cases; in a good many others, those who had been educated at Eton and Oxford, as some of the princes had been, had found themselves on their arrival back in India entirely out of touch with their own people. They arrived at a different standard of surroundings, conversation, morality, and political out-look, and were not happy. He did not think there would be altogether the same difficulty in Siam for various reasons. One difficulty in India was their position in relation to the British official. They would not have that difficulty in Siam; but still the difficulty of going back to a lower state of civilisation after being accustomed to a higher one might very often tell badly. He was curious to learn, also, how the happy family of the heads of Departments, consisting of English, Danish, French, Italian and German, pulled together. The man who had to keep the rats, the cats, the dogs, and the monkeys in one cage must, he imagined, have a happier time than the King of Siam. The author had not referred to a point which had an important bearing sometimes on British relations with Siam, viz., the Malay States. There were one or two small States to the south of Siam which were peopled, not by Siamese, but by Malays, over which the Siamese Government claimed a protectorate. Of late years, since the Malay States had been federated and had had English supervision, the tendency of the southern States had been to refuse to acknowledge the protectorate of Siam, and to gravitate towards the Confederated Malay States. The question caused a good deal of irritation, ending for the present in a compromise by which the protectorate of the Siamese was acknowledged, but an English official was appointed by Siam to each State as official adviser. He had not had an opportunity in the last two or three years of hearing much about that interesting experiment, and he would like to know whether it had succeeded or not. He had found the paper most interesting and instructive, the one saddening reflection being the diminution of British shipping in that part of the world.

The resolution of thanks having been carried unanimously,

Mr. Hillman, in reply, stated that it had given him great pleasure to read the paper. In the early days of his profession, he used, as a very young man, to sit at the reporters' table, and it was one of his ambitions in those days to read a paper before the Society. He had not the faintest idea at the time what the paper would be about, but his wish had been gratified, and one of the ambitions of his youth had been realised that evening. In reply to the Chairman's remarks about the visit of the King of Siam to India, it was an example of the great friendship of the Siamese towards this country that the King, after his Indian tour, was so struck by the English administration of the Native States, which still retained their independence under this country's protection, that he asked the British Government to extend the same protection to Siam. He was sorry the Government of that day was not far-seeing enough to accept that offer, because it would have saved a lot of trouble in recent years, and would, perhaps, have enabled Siam to make further progress. With regard to the question of education, he quite agreed with the Chairman that it must be a difficult thing for a native, who had lived in this country during the years of life when character

and tastes were being formed, to go back to the life of his own people. If he attempted to live the life of a European, he cut himself off from his own people, and destroyed any chance of influencing them, which would naturally be the most valuable outcome of the education he had received. He was afraid, however, that he must suffer for the good of the race. There was no progress without suffering, and individuals had to undergo that suffering. Such natives must be looked upon as martyrs, who suffered in order that the bulk of the people and future generations might receive the benefit. So far they had his pity, but at the same time they must be given the admiration which was due to a martyr. The heads of departments, so far as he knew, got on very nicely together by keeping out of each others way when departmental questions were considered. An Englishman was in charge of the purse and that gave him a very strong position. In the squabbling over the railway, England got its own back when the financial adviser was appointed, because one of the very first things he did was to find fault with the enormous waste of money in the railway department. A good deal was heard at the present time in praise of German methods. The Siamese postal department was under German control; and yet he recently read in a paper that the Siamese Post-office had run out of one att stamps, which was equivalent to the Post Office in this country running out of halfpenny stamps. He would leave the audience to imagine what that would mean in cases where postcards and newspapers had to be posted. The usual course adopted in such cases was to surcharge stamps of a different value, much to the delight of stamp collectors; but it appeared that it would have taken a fortnight to do even that in Siam, so that as a result of German administration, a whole country was without halfpenny stamps for a fortnight. He did not know very much about the Malay States; but he knew that while he was in Bangkok, some chiefs came there to pay their tributes. As he had mentioned in his paper, the tributary nations had always been in the habit in historical times, at any rate, of sending trees to Siam; but as soon as the question arose as to whether they really were tributary to the Siamese or not, some ingenious person discovered that it was not a tribute which the Malays sent, but a complimentary present. He did not think an Asiatic nation, any more than any other nation, would be in the habit of going to a very great deal of trouble and expense to send a complimentary present, which was identical with the tributary presents sent for generations. Whilst he was in Siam, there was a discovery of coal in one of the Malay States, but it was impossible to develop it, owing to want of labour. Recently, the Minister for the Interior had been on an extensive tour through the Malay States, so that he did not think there was any possibility or probability of Siam loosening her hold over them, but rather that she would tighten it, as she had done with the chiefs in the North. Even so recently as ten years ago, the Siamese hold on the Northern chiefs was not very firm, but she had strengthened it since, and he thought the same thing would take place in the Malay States.

THE WORLD'S FUR TRADE.

The fear has sometimes been expressed that the fur-bearing animals are becoming extinct, but the answer to that is that the fur trade in America is larger to-day than ever before. It is time that the buffalo no longer comes into consideration as a fur-bearing animal, and the beaver is also nearly extinct in most countries. The sea otter, which formerly furnished 100,000 furs annually, yields hardly 400, and the seal also seems to be rarer, as the numbers of seal skins has decreased from 100,000 to 10,000 yearly, but other fur-bearing animals have taken the place of these, and the dimensions of the American fur trade are at present greater than they have ever been. The American Vice-Consul at Magdeburg says that the depôts in the United States and Canada send the largest part of the furs they receive to the three famous fur markets of the world—London, Leipzig, and Nijni-Novgorod. The buying itself is done by expert fur brokers. In London the furs are sold by auction, and an average of £1,000,000 worth of undressed furs are disposed of here annually. The principal sale in Nijni-Novgorod takes place in August. There all the Asiatic furs, such as Persian lambs and astrakhans, Mongolian goat skins, and Siberian sables, ermine, rare squirrel furs, and, although in small quantities, otters and seals are sold. The Leipzig market is held at the great fur "Messe" at Easter time. To it come buyers and sellers from North and South America, Persia, China, Siberia, Japan, Tibet, and England. The "Messe" lasts two weeks, and is an interesting relic of old times, which still retains its importance. The question has frequently been asked as to why Germany, which furnishes no fur-bearing animals, plays so important a part in the fur trade. This is due to the colouring and dressing. Whole towns and cities are engaged in the preparation of the raw material. Austria and Russia produce the best squirrel skins for lining, but they must all be sent to Germany to be dressed. The secret of the dressing lies partially in drawing the fat out of the skins without soiling the fur, which is of great importance in the case of ermine, white fox, and Polar bear furs. Many dressers finish the furs with poor fat instead of butter, or do not properly remove the unpleasant odour, as they do not treat the skins with mahogany shavings. Germany takes the foremost place in the colouring of all sheep skins, which is attributed to the composition of the German river water and to the properties of the German clay. There are sent annually to the sales at Leipzig and Nijni-Novgorod 200,000 English fox skins, 500,000 German fox skins, 300,000 Russian fox skins, 90,000 American red fox skins, and over 50,000 Alaskan fox skins of all sorts.

HOME INDUSTRIES.

The Dispute in the Cotton Trade.—It was said in this column on January 3rd, that "amongst the most encouraging of the industrial facts of 1907 was the progress of conciliation," and several instances were given of trade disputes which might have developed into serious industrial crises being amicably settled by the parties to the disputes coming together and discussing matters with a desire to arrive at an arrangement satisfactory to both parties. It is to be hoped that the cotton trade dispute will afford another illustration of common sense winning the day. If this dispute ends in a lock-out it will mean the enforced idleness of about one hundred and fifty thousand operators; and it is hardly an exaggeration to say that no such great disorganisation of the trade was ever before due to so small a matter of variance. As the reader knows, the relations between the employer and employed in the Lancashire cotton industry are governed by a series of agreements which consist of two parts—a standing scale of wages, called a price list, and machinery for discussing and settling differences, as they arise, on the principle of equal representation. The instrument provided for the settlement of disputes is known as the Brooklands agreement, so named from the Manchester Hotel, where it was worked out in 1893. This agreement provides two main points, the one that when a general change of wages has taken place it shall stand for twelve months, and application for further changes shall not be entertained till the expiry of that period, the other that disputes of any kind must be referred in the first instance to joint committees of inquiry, first local, then district, and finally central, and only when there has been failure to arrive at agreement by these means is a strike or lock-out to be allowed. The contention of the employers is that this agreement has been violated in the present dispute. Last June all workers got an advance of 5 per cent., but this has not prevented certain ring spinners at Oldham from demanding a further advance of from 12½ to 19 per cent., in plain violation of the Brooklands agreement, which vitiated any such demand before June of next year. Assuming that the ring spinners are bound by the agreement, there is no answer to the contention; but then the ring spinners say that they do not come under the agreement. The employers reply that official correspondence shows that demands have repeatedly been made on behalf of the ring spinners by the union under the agreement, and this, too, is true. But it is not less true that the Brooklands agreement presupposes a standard wage list from which changes are to start. There were such lists for other hands when the agreement was signed, but there has never been one for the ring spinners, who have become numerous and important only within the last fifteen years—that is to say, since the creation of the Brooklands agreement. The ring spinners, therefore, contend that in equity, if not in law, they are outside the agreement until the list is re-made. It is the fine spinning dispute over again. Fine spinning, too, is a recent innovation at Oldham, and the old list, which existed in 1893, and formed the basis of the Brooklands agreement, did not provide for them. The way out of the difficulty would seem to be simple and obvious. Draw up a ring spinning list. The employees are willing to do so, but they will not admit that the ring spinners are not at present bound by the Brooklands agreement, and so they insist upon a resumption of work before preparing the list. To this the ring spinners consent provided the Brooklands agreement is not urged against them afterwards. At the moment of writing settlement is not assured, but it is very probable. The cardroom amalgamation officials have already expressed their willingness to acknowledge the Brooklands agreement as binding on the ring spinners after a universal list has been completed, and it is difficult to understand why such an acknowledgment should not be made before a list is discussed.

The Shipbuilding Outlook.—A notable feature of the shipbuilding industry of last year was the increase in the number of ships built. If the total output of tonnage for 1906 and 1907 is compared, it will be found that there was a decrease of 187,020 tons in 1907 as compared with 1906—1,814,961 as against 2,002,571—and of the horse-power of 69,235—1,776,768 as against 1,846,003; but in the number of vessels built there was an increase of no less than 454—1,825 as against 1,371 in 1906. The explanation is to be found in the exceptional demand for small fishing steamers, harbour barges, and vessels sent away in sections to be reconstructed abroad. Many of these vessels were built not in yards in the principal centres, but in minor outports. If the shipbuilding figures of the world for last year are taken, it will be found that the Clyde alone provided more vessels of a greater tonnage and horse-power than any other country in the world. The figures are very significant—

	Vessels.	Tons.	I.H.P.
Clyde	526	619,919	668,527
United States	177	455,713	304,831
Germany	507	321,372	279,097

Excepting America, the output of the Tyne exceeded that of every country; the Wear runs Germany hard—295,432 tons as against 321,372—and the Tees and Hartlepool are not far behind. It is a wonderful record. Unfortunately, it is long since the outlook for the shipbuilding industry has been worse than at the present time. What with the number of cargo tramps added in the last two or three years to the mercantile marine, and the new passenger liners, with their great cargo-carrying capacity, the requirements of the sea-carrying trade, great as they are, are more than supplied. Instead of ordering new steamships, owners are considering the desirability of

laying up a large number of vessels. Material is lower, and labour is coming down, but there is a sharper falling off in the demand for new vessels, the decline being most noticeable in cargo steamers. Nor is any early renewal of the demand for these steamers probable.

The Brewing Industry.—In view of coming legislative proposals, and of the importance of an industry in which careful estimates place the amount of capital invested at from a minimum of about £200,000,000 to a maximum of about £250,000,000, interest attaches to a list of brewery companies, compiled by the *Statist*, in which their financial position is shown. This list is restricted first of all to those companies that publish accounts; secondly, to those companies whose share and loan capital is quoted on the London Stock Exchange; and thirdly, only to those companies whose combined share and loan capital is not less than £270,000. In the 78 companies noticed, there is a total capital of nearly £90,000,000, or getting on for half the probable total capital invested in the industry. It is made up as follows:—Debentures, £40,634,932; Preference, £25,804,702; Ordinary, £23,216,225. On this total capital of £89,655,862, the net profits earned have amounted to £5,626,149, or a return of about 6¼ per cent. The average rate of interest on the debenture capital is about 4·09 per cent., the average rate of dividend paid on the preference capital employed is about 4·58 per cent., and the average dividend earned on the ordinary capital is a little under 12 per cent., the average rate of dividend paid being 6·71 per cent. When it is remembered that these results are from the pick of the trade, and that the return to the investor would be considerably less if an average was taken of the whole of the brewing industry, it will hardly be thought that it is excessive. As to whether the spread of temperance principles is likely to affect adversely the consumption of alcoholic liquors, it can only be said that the available statistics do not enable a decisive opinion to be formed as to whether the nation is becoming more temperate. Of late years there has unquestionably been a decline in the consumption of beer and spirits. The consumption of beer *per capita* in 1899 was 32·53 gallons, after which there was continuous decline until 1906, when it rose to 27·96 as against 27·42 in the preceding year. The latest available figures for comparison are those to September 30th, 1907, and they show that for the twelve months preceding the total clearances of beer for home consumption amounted to 33,761,903, as against 33,492,245 barrels for the preceding twelve months. This suggests increasing consumption, but then for the three months ended September 30th, 1907, the last quarter of the comparison, there is a fall of 220 barrels, as against the consumption in the corresponding quarter of 1906, which may or may not be due, or due in part, to the exceptionally wet summer of 1907. A similar state of things has prevailed in the consumption of spirits. There has been recovery concurrently with the improved industrial conditions, but it has not been of sufficient duration to establish conclusively the correctness of the contention that the consumption of beer and spirits in the United Kingdom is affected rather by the surplus available for expenditure on articles of luxury than the growth of temperance.

London as a Distributing Centre.—It would seem as if London runs some risk in connection with its position as the chief retail distributing centre in the kingdom. It must always command a large share of the wholesale trade and has the advantage of fashionable prestige. But Manchester has long been the head-quarters of the heavy drapery trade and is making inroads into other departments. In the case of heavy goods it has long been claimed that Manchester is a cheaper market than London, not only for the textile products of the north of England but also for linens. Canadian and United States dry goods buyers are said to show a decided preference for Manchester for purchase of domestic goods. The larger American buyers each send several representatives regularly to Europe from their various departments. Australia and the Cape still favour London as a buying centre but not to the same extent as formerly owing to the action of north of England, Scotch, and to a lesser extent of Irish houses in catering direct for the colonial demand. The idea that Manchester stands for cotton goods alone is gradually being rooted out, the result being that in the shipping as in the linen trade London is the loser.

Fire Insurance—Some interesting figures are to be found in the returns supplied by the various insurance companies for the purpose of apportioning their respective contributions towards the maintenance of the Fire Brigade. The companies are expected to contribute on the basis of £35 per £1,000,000 of sums assured, which makes their contribution about £36,000 in 1908. The total amount of insurance effected is £1,026,467,680, exclusive of policies issued by Lloyd's, and of this total the Alliance is credited with £246,650,333, these figures including policies issued by the Law Fire Office, recently acquired by the Alliance. The Sun Fire Office is second on the list with £114,357,874, and following close is the Commercial Union with £113,607,602, inclusive of the amounts covered by the Union Assurance Society, whose business it acquired last year. The Royal and the Phœnix insure £72,042,530 and £66,559,199 respectively, and the London, Liverpool, and Globe £46,777,104, the North British and Mercantile not being very far behind with £42,540,380. All these are tariff offices. The largest of the companies outside the tariff is responsible for only £13,217,436, Lloyd's insurance against fire being about the same, £13,589,906. The Alliance contribution to the Fire Brigade this year works out at £8,632 15s. 2d.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

JANUARY 29.—"Reform of the Patent Law." By JOHN WILLIAM GORDON. SIR WILLIAM PREECE, K.C.B., F.R.S., Vice-President of the Society, will preside.

FEBRUARY 5.—"War Balloons." By AUGUSTE E. GAUDRON. The HON. CHARLES STEWART ROLLS will preside.

FEBRUARY 12.—"The Application of Science to Foundry Work." By ROBERT BUCHANAN, President, Staffordshire Iron and Steel Institute.

FEBRUARY 19.—"The Law of Treasure Trove." By WILLIAM MARTIN, M.A., LL.D.

FEBRUARY 26.—"The Problem of Road Construction, with a View to Present and Future Requirements." By PROF. H. S. HELE-SHAW, LL.D., F.R.S., and MR. DOUGLAS MACKENZIE. SIR JOHN WOLFE-BARRY, K.C.B., LL.D., F.R.S., will preside.

MARCH 4. — "Modern Dairy Practice." By LOUDON M. DOUGLAS.

MARCH 11.—"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By ERNEST R. MATTHEWS, F.R.S.E., Assoc.M.Inst.C.E.

MARCH 18.—"Impressionist Painting : its Genesis and Development." By WYNFORD DEWHURST, R.B.A.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

FEBRUARY 13.—"The New 'Imperial Gazetteer of India.'" By RICHARD BURN, I.C.S. (To be read by WILLIAM FOSTER.)

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

JANUARY 28.—"The Development of Colonial Self-Government in the Nineteenth Century." By A. BERRIEDALE KEITH, M.A., B.C.L., M.R.A.S., of the Colonial Office. The RT. HON. SIR CHARLES WENTWORTH DILKE, Bart., M.P., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

FEBRUARY 18.—"Banners in Pageantry." By GEORGE W. EVE. WALTER CRANE, R.W.S., will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

HENRY HARDINGE CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." Six Lectures.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

FEBRUARY 7.—"The Hygiene of the Pottery Trade." By WILLIAM BURTON, F.C.S., Chairman of the Joint Committee of Pottery Manufacturers of Great Britain.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Henry Hardinge Cunynghame, C.B., "The Theory and Practice of Clock Making." (Lecture II.)

East India Association, Caxton-hall, Westminster, S.W., 4 p.m. Mr. C. W. Whish, "Some Lessons from History on the Problems of Indian Administration."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. A. W. Crampton, "Some Urban Land Problems."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. A. E. Carey, "Prehistoric Man on the Highlands of East Surrey."

TUESDAY, JAN. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) Mr. A. Berriedale Keith, "The Development of Colonial Self-Government in the Nineteenth Century."

Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS, John-street, Adelphi, W.C.), 11 a.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. J. Haverfield, "Roman Britain: (a) Its Frontiers and Garrisons."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Sir John W. Ottley and Dr. Arthur W. Brightmore, "Experimental Investigations of the Stresses in Masonry Dams subjected to Water Pressure." 2. Messrs. John S. Wilson and William Gore, "Stresses in Dams: an Experimental Investigation by means of India-rubber Models." 3. Mr. Ernest Prescot Hill, "Stresses in Masonry Dams."

Anthropological, 3, Hanover-square, W., 8½ p.m. Annual Meeting.

Horticultural, Vincent-square, Westminster, S.W., 3 p.m.

WEDNESDAY, JAN. 29...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. John William Gordon, "Reform of the Patent Law."

United Service Institute, Whitehall, S.W., 3 p.m. Vice-Admiral Sir C. Campbell, "The Strategical Advantages of a System of Communication by Mono-Rail for Rapid Concentration of Armed Forces in any Threatened Area."

THURSDAY, JAN. 30...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. A. J. Windus, "Municipal and Company Finance—a Contrast."

Royal Institution, Albemarle-street, W., 3 p.m. Major Martin Hume, "The Story of the Spanish Armada." (Lecture I.)

FRIDAY, JAN. 31...Royal Institution, Albemarle-street, W., 9 p.m. Prof. Rutherford, "Recent Researches in Radio-Activity."

Child Study Society, Parkes Museum, Margaret-street, W., 8 p.m. Professor W. A. Baldwin, "Physical Activities as a Basis for Education in Home and School."

SATURDAY, FEB. 1....Royal Institution, Albemarle-street, W., 3 p.m. Mr. Lionel Cust, "Anthony Van Dyck." (Lecture I.)

Journal of the Royal Society of Arts

No. 2,880. VOL. LVI.

FRIDAY, JANUARY 31, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

ROYAL SOCIETY OF ARTS.

His Majesty the King, who is Patron of the Society, has granted permission to the Society to prefix to its title the term "Royal," and the Society will consequently be known in future as the "Royal Society of Arts."

NEXT WEEK.

MONDAY, FEBRUARY 3, 8 p.m. (Cantor Lecture.) H. H. CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." (Lecture III.)

WEDNESDAY, FEBRUARY 5, 8 p.m. (Ordinary Meeting.) A. E. GAUDRON, "War Balloons."

FRIDAY, FEBRUARY 7, 8 p.m. (Shaw Lecture.) WILLIAM BURTON, "The Hygiene of the Pottery Trade."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 27th instant, Mr. H. H. CUNYNGHAME, C.B., delivered the second lecture of his course on "Theory and Practice of Clock Making."

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, January 28th; The RIGHT HON. SIR CHARLES WENTWORTH DILKE, Bart., M.P., in the chair.

The paper read was "The Development of Colonial Self-Government in the Nineteenth Century." By A. BERRIEDALE KEITH, M.A., B.C.L., of the Colonial Office.

The paper and discussion will be published in a future number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, January 16; SIR JAMES MONTEATH, K.C.S.I., in the chair.

The CHAIRMAN (Sir James Monteath) said he did not think Mr. Lawrence needed much introduction. Probably everyone present knew that he was one of the ablest members of the Bombay Civil Service. As an executive officer in several districts of the province, including Sind, Mr. Lawrence had opportunities of studying the agricultural conditions, and he had taken special advantage of those opportunities. On that account he had been selected to be Director of Agriculture when that office assumed increased importance and required increased activity. During the greater part of the time in which he held the appointment, it was his (the Chairman's) duty to consider Mr. Lawrence's reports and proposals, and he also visited from time to time with that gentleman some of the farms and institutions under his direction, and could vouch for the intense interest, zeal, energy, and ability which he devoted to the work. It was in the course of Mr. Lawrence's tenure of that office that Lord Curzon's Government found that they had considerable sums of money to spare for objects of public benefit which had not previously been adequately provided for. Lord Curzon very wisely determined that measures tending to the improvement of agriculture had a high claim to a share of the surpluses. The detailed arrangements for utilising such money allotted to Bombay in carrying on agricultural research, acquiring further suitable areas for experiment and demonstration, teaching young men to experiment and to demonstrate, and in various other ways calculated to make agriculture more efficient, were almost entirely due to Mr. Lawrence's initiative. He thought it would be difficult to find any one more competent than Mr. Lawrence to deal with the subject of Indian agriculture.

The paper read was—

INDIAN AGRICULTURE,

By Henry Staveley Lawrence, I.C.S.,
Director of Agriculture, Bombay.

There is scarcely any subject, even in the wide field that India presents for controversial treatment, on which you will find so much divergency of opinion and such extreme contradiction of statement as on the subject of Indian Agriculture. The excellent Mountstuart Elphinstone, in the standard history which he published some seventy years ago, wrote: "The nature of the soil and climate makes agriculture a simple art," and this view is still upheld by those authorities who maintain that the Indian peasant knows all that is worth knowing about the capabilities of his soil and the cultivation of the crops suited thereto.

On the other hand, competent scientific observers lay stress upon the complex and difficult conditions of agriculture in India, point to the wonderful improvements which Western science has effected in Europe and America within the last century, and assert confidently that the same principles, when applied to India, will promote the efficiency of agriculture in a remarkable degree. This school would have us believe that their antagonists, eminent though they may be in all other branches of human knowledge and practical administration, yet have an insufficient acquaintance with the history of agriculture and of the progress of science.

In every country the position of agriculture is closely connected with the economic history of the people. It would clearly be impossible to place before you within the narrow limits of an hour's lecture, a comprehensive account of the vast range of subjects which invite discussion; and I am compelled not only to confine myself to a few of the more salient aspects, but to treat even these with a wide generality of statement. I have drawn my illustrations chiefly from Western India, to which my personal experience extends, and since India is a continent, every statement must be taken as subject to numerous exceptions.

Influence of Caste.

The assumption that agriculture in India is a stationary art, stereotyped in the mould in which it was cast thousands of years ago, is a common misapprehension. It is no doubt true that in early days changes took place slowly. If the system established under the laws of Manu—whereby all society was divided into four sections, the Brahman priests, the Kshatriya warriors, the Vaisya traders and agriculturists, and the Sudra menials—secured the tradition from father to son of the specialised knowledge of agriculture in a distinct caste, and represented an advance on the primitive methods of nomad barbarism, it nevertheless tended, at a time when education was confined to Brahmans, to prevent the communication of ideas, and the transference of agricultural improvements from one tract to another. Everything in India has its roots so deep down in the past that this old-world system exercises a potent influence on the conduct of the people at the present day. When we find the great landlords of the Brahman and soldier castes holding themselves aloof from the practical administration of their estates, we are reminded that agriculture is scarcely mentioned in the voluminous records of the sacred books which prescribe the daily duties of Brahmans and warriors in minute detail. In certain tracts, indeed, the belief is current that orthodox Brahmans are not permitted to engage in agriculture. Fortunately, these prejudices are not of universal application, and are waning; and where, as in parts of Western India, the Brahmans were compelled by the increase of their numbers to undertake secularised occupations, they brought agriculture to a very high pitch of perfection.

This interesting fact deserves a moment's digression in view of the criticisms that are sometimes heard of the inefficiency of the Brahman as a man of business, and the futility of seeking his aid in the improvement of agriculture. It may be admitted that the Brahman will not turn to practical work in the field or laboratory except under the pressure of severe compulsion; for he is not only as tenacious of his claims to a free maintenance by the community as the high-born classes of Western Europe, but also honestly reluctant to abandon the doctrines of his religion, which forbid the acquisition of wealth and enjoin abstinence and meditation in his closing years. The law of self-preservation, however, has never appealed to the Brahman in vain. The intellectual pliancy which enabled him to incorporate animistic beliefs in his philosophy, and to undermine the popularity of Buddhism, will not fail him in the present crisis.

There are evident signs that he recognises the overpowering constraint of the Material Age in which his lot has been thrown—that Kali Yuga when "the usages and institutes of

caste, of order and of rank, will not prevail, nor yet the precepts of the triple Veda." As a hundred years ago Brahman soldiers took a conspicuous share in the conquest of India for the East India Company, so now Brahman students are preparing to play their part in the industrial and agricultural awakening of India.

To return to the cultivator: the rigid distinction of castes, and the absence of guidance or control by the superior landlords have been the underlying causes of the variations in agricultural skill and the irregularity of progress exhibited in homogeneous tracts throughout the country. But early records, if scanty, suffice to show that in spite of all obstacles important changes did take place; and in proportion as India has been brought more and more closely within the influence of the forces that are binding the world together in an universal community of commerce, the rapidity of these changes has been greatly intensified.

Ancient Agriculture.

Agriculture did not bulk largely in the earliest historical account of the trade of India, for we read that the Phœnician pilots of the fleets of King Solomon brought, from India, gold and silver, ivory, apes, and peacocks. To the Romans, India furnished diamonds and pearls, silk, and spices, such as frankincense, cassia, and cinnamon for funeral ceremonies and the worship of the gods. In the Arab and Mogul period, cotton and sugar-cane had come to the front; three hundred years ago, pepper, spices and indigo aroused the rivalry of the Dutch, Portuguese and English mercantile companies. A century ago, the exports of the East India Company, comprised cotton, silk, wool, gum, spices, indigo, and coffee, and were valued by them at £2½ million sterling.

Last year the exports amounted to £105 millions, of which jute and tea—two new products discovered in the course of last century—accounted for £20 millions and £6 millions respectively; and other chief items were cotton £24 millions, rice £12 millions, wheat £6 millions.

To the general rule that Hindu Governments paid little attention to agriculture, one important exception must be made. In Southern India irrigation was fostered by the remarkable system of tanks or reservoirs for the storage of water, and by the construction of anicuts in the deltas of the Madras rivers. In the dearth of historical memorials of Hindu rulers, the origin of these works has been forgotten; but the river canals can only have been undertaken by rich and powerful princes, while the storage reservoirs were probably created by village communities or wealthy citizens as acts of charity. In former days it was the custom for the local banker to ease his conscience, and seek the blessings of posterity by lavish expenditure on the provision of water and shade for the benefit of his village. With the modern assumption by the State of responsibility for these objects, and the new sense of security for the transmission of property by inheritance, this custom has fallen into abeyance. The motive, however, which inspired these benevolences, whether we call it public spirit or private charity, is not dead, and if it could be brought forth once more into active operation, its effect on the promotion of agriculture would be incalculable.

Mohammedan Period.

Let us now turn to the period of the Mohammedan domination from the twelfth to the seventeenth centuries.

The Moslem invaders, sweeping over many countries, showed a genuine appreciation of the good things in each, and carried out a most useful interchange of methods and products. From the Euphrates and the Tigris they introduced into northern India and the Deccan the system of irrigation canals. Wherever they went, they either imported or improved the cotton-plant and the sugar-cane. In considering the claims of the Mogul Emperors to fame, we are apt to regard exclusively their military and administrative achievements, the splendour of their court, and the magnificence of their architecture; and to overlook the credit they deserve for their intelligent patronage of agriculture and irrigation. But the great Baber—the contemporary of our Henry VIII.—in his fascinating autobiography tells us himself of the interest he took in the transference of sugar-cane from one tract to another, and in the cultivation of fruit orchards; Jehangir again, in his memoirs, makes a special mention of the introduction of tobacco, although in terms of disapproval; and from the records of Akbar we learn of the importation from Persia of agricultural experts. It is common knowledge that the English administration is closely modelled on the Mogul prototype, but it is interesting to find a precedent for the latest creation of English genius, the Department of Agriculture: and it is even possible

that if success is to be attained in the experiments now in progress for the cultivation in Sind and the Western Punjab of Persian dates we may have to send to Persia for the lineal descendants of Akbar's scientific gardeners.

It is wholly unnecessary for me to remind you of the royal encouragement to agriculture in this country, but in India his gracious Majesty's example does not as yet find many imitators. In Hindu States the ethics of rule do not inculcate this duty, and in Mohammedan States the teaching of the Koran that agriculture is of divine origin receives scanty recognition. It is true that when his Majesty as Prince of Wales founded the Imperial Institute for the development of agriculture throughout the Empire liberal donations were obtained from India, but we hear little in India of the practical interest and sympathy of native rulers such as is manifested by his Majesty in his constant attendance at and participation in agricultural shows, and his patronage of such enterprises as the British Cotton Growing Association.

Cotton.

From the earliest ages cotton has been one of the chief products of India, and some account of its history will not be inappropriate here. We need not go back further than the time of Alexander the Great whose admiral, Nearchus, wrote of the "fleeces that grow on the trees in India," and we know now from the researches of Sir G. Watt and other eminent scientists how accurate his description was, for in those days cotton was grown not as an annual plant but as a perennial tree. There is little doubt also that the outturn of these fleeces was exceedingly scanty, and was held in very high estimation. Thus, in China a cotton robe was one of the most valued possessions of the Emperor, and in India the Brahmans selected cotton to form the sacred cord of their caste, while they allotted hemp to the soldier and wool to the trader. To this day the sacred cord of the orthodox Brahman is taken from the Dev Kapas tree, the Holy Cotton Tree, which is grown as a perennial in gardens.

It is probable that it was during the Mohammedan period that the most important discovery was made that the cultivation of cotton as an annual plant rendered it possible to obtain a far larger crop of lint, to refresh the soil by rotations, and to preserve the tree against the insect pests to which it is peculiarly liable.

The Mohammedans also carried the knowledge of cotton cultivation from India to the Mediterranean and to Spain; and it was from the Levant that the first supplies of cotton came to make Manchester the emporium of the cotton trade in the early days of the Stuarts.

At the same time the cultivation of the plant was begun in the United States from seed obtained both from the Levant and from the West Indies, though 150 years were to elapse before the States seriously set themselves to export cotton to England. As soon as the East India Company found themselves free from the danger of annihilation in the wars of the eighteenth century, they turned their attention to the improvement of the cotton trade. In 1788 consignments of superior seed were imported and distributed throughout the peninsula; and steps were taken to compress and pack the cotton in bales. A few years later bounties were offered for improved samples of cotton. In 1813 the first American cotton expert was despatched to India, and took with him a number of New Orleans saw-gins. In 1816 the export of cotton was encouraged by exemption from all the internal and export duties then levied on the transport of produce in and from India. Tariff Reformers are, no doubt, aware that between 1803 and 1831 preferential rates of import duty were levied in England, which in the latter year represented 4d. per cwt. on cotton from British possessions, and 5s. 10d. on foreign cotton.

Between 1816 and 1840 various measures were taken; bounties were given for certain qualities of cotton; seed was introduced from all parts of the world, and attempts were made to improve the native methods of cleaning the cotton.

In 1840, ten American planters were brought to India, and were placed in charge of experimental farms in all the three Presidencies. Their experiments were extended over a period of ten years, but it was found impossible to acclimatise American cotton to Indian conditions except in a small corner of the Dharwar district in Bombay.

After the cotton famine of the American Civil War many of these measures were repeated, but once more without success.

Economic Progress.

This summary may serve to show that the cotton problem is not so easy of solution as enthusiasts at home are inclined to imagine,

and that the Government of India are not open to the reproach sometimes levelled at them of indifference to the cotton interest. A long course of disappointing failures led by painful steps to the adoption of a sound policy of economic progress. It was at length realised that the first need of the country was facility of transport, and the provision of organised agricultural enquiry based on the co-operation of the people. In the first half of the last century there was no co-ordination in the experiments made in different regions; it is true that success was attained with such products as tea, indigo, and coffee, which offered a favourable field for European enterprise in suitable climatic conditions, but Government possessed no skilled agricultural advisers to investigate and advance the cultivation of the staple crops. Sometimes, as in the case of cotton, the measures adopted met with active opposition from the people, who saw no advantage in growing the superior quality of lint. The cotton exports of those days were barely five per cent. of the total produce, and the inferior fibre not only was suitable for the internal consumption of India, but commanded an equal price, and was more secure in outturn. Whatever the reasons may have been, it was reported that in many places the native capitalists employed men to go out at night and root up the American seedlings in the experimental farms.

Up to 1850 the East India Company had paid little attention to roads, canals, or other public works. The Court of Directors stated that their average annual expenditure on all public works in India was about a quarter of a million sterling. An urgent demand sprang up for the construction of roads and railways. The railway mania in England was at its height, and the English commercial community raged with indignation against the apathy of the Indian Government. Those critics who complain now of the insufficiency of an annual Budget of £10,000,000 for the extension and equipment of railways would find consolation and support in reading the remarks of their predecessors, when it took fifteen years of negotiation to build the first fifteen miles of railway from Bombay to Thana.

The famines that occurred then were as terrible in their results as those that preceded the establishment of British rule. In a petition presented to the House of Lords in 1853, we read:

"Famines occur decennially, some of which, within our time, have swept their millions away. . . . The living preyed upon the dead; mothers devoured their children, and the human imagination could scarcely picture the scenes of horror that pervaded the land. In twenty months' time 1,500,000 people must have died of hunger or of its immediate consequences. The direct pecuniary loss occasioned to Government by this single visitation exceeded £5,000,000 sterling, a sum which would have gone far to avert the calamity had it been expended in constructing thoroughfares to connect the interior with the sea coast, or districts where scarcity prevailed with those where human food was to be had in abundance."

The strong arm of the English administration has within the space of half a century banished these horrors into the abyss of oblivion, but it is well for us occasionally to reflect on the methods by which this humanitarian resolution has been accomplished and the fundamental conditions of its maintenance.

During this period of unbroken internal peace, the energies of the Government have been devoted to the prosecution of railways, roads, irrigation canals, and education—the four requisites which are equally essential to preservation from famine and the economic and agricultural development of the country.

At a cost of some £250 million sterling, over 30,000 miles of railway have been constructed, of which two-thirds are the property of the State; metalled roads cover 37,000 miles, and unmetalled roads some 140,000 miles, and the annual expenditure on their extension and upkeep, approximates £3,000,000. In irrigation works, the capital expenditure up to date amounts to £30,000,000, and 43,000 miles of canals and distributaries irrigate an area of 16 million acres. Incidentally, I may observe that the State assets in the form of railways and canals represent three-fourths of the whole public debt of the country.

The policy thus steadily pursued has transformed the agricultural economy of whole provinces. I will mention a few instances only. When visitations of famine occur now, the people are spared the ultimate calamity of the absence of supplies of food. The network of adjacent railways brings an ample provision of grain into the afflicted area; when all hope of a harvest is at an end, and the labourer and small peasant can no longer find employment in the barren fields, they are secure of subsistence by labouring on the relief works organised by the State. Let me illustrate the result of this change. In the famine of

1876-77 a corner of the district of Bijapur was cut off from the railway by 150 miles of difficult country; grain was scarcely obtainable, the people fled in all directions, and out of an area of 360,000 acres 60,000 acres were utterly abandoned in the following years, the owners either having died or having been reduced to the class of landless labourers. Thirty years later when a railway traversed this district the same tract was smitten by an equally severe drought but not a single acre fell out of occupation. No impediment to agriculture was comparable to the devastation caused by famine when villages were deserted and fields lay waste and untilled; and the protection conferred on the cultivator by the railway was the first step to the improvement of agriculture.

It is difficult for us now to imagine the days when the greater part of British India possessed no roads that would allow of the employment of carts; yet such was the case fifty years ago, when except where navigable rivers provided a waterway, the whole merchandise of India was conveyed on pack-bullocks, or baggage-camels. Let us consider the cotton of Berar and the Central Provinces. Bullocks carrying loads of a couple of hundredweight of cotton, used to march the whole of the four hundred miles to Bombay through districts where the animals suffered from drought, and through hills where robbers pillaged the cotton. We can realise that the cultivator did not grow rich on his share of the price finally obtained. Even after the American war had raised the price over two shillings to the pound, the exports of these provinces amounted only to 270,000 bales, while in 1905, with a price of 4¼d. per lb., the exports had increased by 900,000 bales, and the cultivation by 3,000,000 acres. Of changes in the methods of production no record is available, but the statistics show that an acre of cotton represented an export of 60 lbs. of lint in 1866 and of 100 lbs. in 1905, and, however little reliance we may be disposed to place in statistics, there are clear indications that a great advance in agricultural efficiency coincided with the development due to the construction of roads and railways.

To the results of irrigation I will refer later on, but here as an instance of an important change, I would quote the production of wheat on areas which have been reclaimed from the desert in the Punjab and Sind. Ten years ago India was not recognised as a source of supply for wheat for Europe; three years ago she exported over 2,000,000 tons, almost wholly the produce of the irrigation canals, and furnished this country with a quarter of her total provision of wheat.

Establishment of Department of Agriculture.

If this retrospect proves the fallacy of the view that Indian agriculture is, or has ever been, in a condition of unprogressive immutability, it remains to consider the responsibility of the State in regard to the guidance and encouragement of its progress, the machinery of the new Department of Agriculture, the programme of its work, and its prospect of success.

The arguments which are used in this country against State action, and which appear even here to be losing their influence on public opinion, are not equally applicable to India. The classes which possess wealth or landed estates are divorced by sentiment and tradition from the pursuit of agriculture, and the State is face to face with a vast peasant tenantry who are debarred by their ignorance from any knowledge of agricultural developments outside their village, and by their poverty from risking the smallest loss in new experiments.

Further, in a country where the land is nationalised, and the State draws one-third of its revenues from the national rental, it is peculiarly incumbent on the State to discharge functions which in a different economy may be regarded as the sphere of the private landowner.

This is, indeed, no new doctrine, though circumstances have conspired to postpone to the present time effective measures towards its realisation.

In 1854 the Court of Directors in the famous despatch which established higher education in India stated their opinion that "there was no single advantage that could be afforded to the vast rural population of India that would equal the introduction of an improved system of agriculture."

In 1870 the Government of Lord Mayo established a department of Revenue and Agriculture in the belief that Indian agriculture was "susceptible of almost indefinite improvement."

The Department was abolished nine years later owing to financial pressure, but was re-established by Lord Ripon, in 1884, with the object of "maintaining agricultural operations at the highest attainable standard of efficiency." In pursuance of the instructions then laid down, valuable work was done in the preliminary study of agri-

cultural conditions, the collection of statistics, the organisation of a system of agricultural credit, and in several provinces the investigation of the relations of landlord and tenant, with a view to the protection of tenants against rack-renting; but it was not until 1902 when Lord Curzon applied himself to the problem that a body of scientific workers was appointed to the Department.

This staff has necessarily been recruited from European scientists, for education in India has not hitherto included a knowledge of the sciences subsidiary to agriculture, such as agricultural chemistry and agricultural botany, mycology and entomology; but though the direction must remain for a considerable period of time in European hands, the discovery and application of improvements must depend on the cooperation of the natives of the soil, and the first step to progress is recognised to be the establishment of Colleges of Agriculture in all the chief provinces.

Agricultural Education.

It is true that four agricultural institutions were in existence at the time, but all were, broadly speaking, inefficient. At Poona, five students picked up such fragments of information as a single officer, whose work extended over the Presidency of Bombay, could find time to give them. At Saidapet, in Madras, there was a similar course of instruction, conducted as at Poona, in English. At Cawnpore and Nagpur, courses were held in the vernacular languages, and teachers were recruited from the Poona and Saidapet institutions. Now new colleges have been established at Lyallpur in the Punjab, Bhagalpur in Bengal, and Coimbatore in Madras; Saidapet has been abolished; Cawnpore and Nagpur have converted their curriculum into English; and Poona has been expanded and improved. I am not acquainted with the details of the changes elsewhere than at Poona; but all the institutions follow the same model and at Poona there are now three full-time European professors of agriculture, chemistry, and botany, with Indian assistants in these branches and in entomology and veterinary science. For the present, work is being conducted on temporary premises, but an estate of 160 acres has been purchased on which the college is in course of construction with a full equipment of laboratories and lecture-rooms, to be followed shortly by residential quarters for the professors and 200 students. Great stress is laid on practical work in the field, and Poona is well furnished with opportunities. A home farm of fifty acres is attached to the college; a dairy farm of similar size is adjacent; within three miles there are 100 acres of botanical gardens, and eight miles distant the sugar-cane experimental farm at Manjhri. Students join about the age of seventeen, when they have passed the previous examination; that is, when they have taken the first year's course leading to the arts degree at the university, and have thus received a fair general education and acquired a good working knowledge of English. The college course extends over three years, after which the candidates selected for the Department of Agriculture spend a further period of probation in practical duties on the experimental farms. In a few exceptional cases men have been sent on to Cambridge to fit themselves for appointment to the higher posts in the new provincial service.

Fears were expressed that an agricultural training would have no attraction for the educated youth of Bombay, and that the college would stand empty. So far these fears have been falsified. Where some years ago there were five students, there are now 95. The popularity of the new college is not solely due to the awakening of an interest in agriculture throughout the country; although indications of such a movement are not wanting, the field of private employment is as yet restricted. For the most part the students desire Government service either in the agricultural or revenue departments; and the latter has recently been thrown open to them by the Government of Bombay in the belief that an agricultural training can be as truly educative as a literary training, and that habits of scientific observation cannot fail to be beneficial to officers whose duties bring them at every turn into contact with village life.

The view was also put forward that in order to bring the college within the reach of the agricultural classes, instruction should be imparted in a vernacular language and not in English. The old controversies die hard; the arguments with which Lord Macaulay demolished his adversaries in 1835 are equally valid to-day; while in the Bombay Presidency where five distinct vernacular languages are spoken, English is the only possible *lingua franca*. Moreover, English education has so pervaded this Presidency that it is no longer the monopoly of the professional classes; and as a matter of fact, of the Poona students, the majority had hereditary associations with the possession of land.

Organisation.

The new policy demands a considerable increase of expenditure. In the Bombay Presidency in place of an annual Budget of £3,000, which was chiefly devoted to the tabulation of agricultural statistics, there is now a Budget of £35,000. I have not access to the figures in other provinces, but an estimate of an increase for all India from £10,000 to £200,000 would not be far from the mark. When the schemes for the creation of the Department were laid before the Legislative Councils of the Government of India and of all the provinces, no adverse criticism was heard from any quarter. No projects, not even proposals for the remission of taxation, have ever been greeted with greater unanimity of approval from the representatives of Indian public opinion, and, indeed, if we compare the allotment with the size of the country, or the scope of the operations of the department, it ceases to appear extravagantly liberal. Our American friends, who spend £2,300,000 a year on their department, and are satisfied that they get their full value for their money, would regard it as a very humble beginning.

The organisation of the department is as follows:—At the head stands the Inspector-General of Agriculture to the Government of India; whose functions are to advise that Government on all agricultural questions, to superintend the work of the Research Institute, established at Pusa, in Bengal, and to observe the operations of the several provincial departments, with a view to their co-ordination.

The Research Institute, at Pusa, is announced to be primarily concerned with "the solution of the fundamental problems of tropical agriculture." The staff comprises European scientists in agricultural chemistry and botany, entomology, horticulture, mycology, and plant physiology; and a number of native assistants in these sciences.

Each local Government has a separate provincial department in the charge of a Director appointed from the Indian Civil Service, who advises his Government, administers the department, and keeps it in touch with the officers of the revenue, forest, irrigation, and other cognate departments and—most important of all—interprets its work to the landowner and the cultivator.

Under the Director there is the educational work of the College of Agriculture and the executive work of the experimental stations. For the latter purpose the province is divided into two or more circles, each under the supervision of a European agricultural expert, styled the Deputy-Director. This officer studies the crops of chief importance in his circle, and the local conditions and methods. In the botanical and chemical problems involved he has the assistance of the professors of the college. His programme of experiments is drawn up in consultation with them and is annually subjected to criticism by the Board of Agriculture. This Board includes the whole agricultural staff of India, and meets in conference once a year; by the interchange of information and criticism it is hoped to secure continuity in the experiments and to avoid unnecessary duplication and repetition of enquiries.

In the Bombay Presidency, where five years ago there were three experimental stations, there are now thirteen. Each is in charge of a native officer of good education who has been specially trained in the department. Two of the farms, which are intended to serve as seed farms for the distribution of selected seed of cotton and millet, have areas of over 200 acres; the rest vary in size from 20 to 75 acres.

Administration.

Up to date the work of the department has been chiefly, in the most literal sense, preliminary spade work; the preparation of the farms for experiments. The impatient reformer who seeks for revolutions in India will meet with disappointment in Indian agriculture as in other fields of activity. Some advocate the establishment of agricultural associations in every district, and demand, as is the way of the East, that Government should finance their operations; others suggest that to every school there should be attached a farm or garden, not merely as a useful guide to Nature-study, but for the demonstration of new crops and methods. Such measures would throw open the door to lavish waste of money, and in many cases prove wholly mischievous.

The difficulty of securing the judicious treatment of a new plant or method can be appreciated by all who have tried to introduce an exotic into their gardens under the care of an old-fashioned gardener, but where the problem comprehends also the application of an untried fertiliser, and the minute comparison of the cost of each operation, from the preparation of the soil to the marketing of the produce, the disasters which attend on the ignorance or carelessness of an untrained

staff are many times multiplied. An error in the management may destroy the result of the experiment, and an error in elaborate calculation of the costs may place an improvement beyond the reach of the small cultivator. And the capacity of the small cultivator is the standard by which almost all improvements in India must be regulated. It is futile, for instance, to preach to him the advantages of deep ploughing in tracts where his cattle are too small and weak to draw a heavy plough, or where he cannot afford to buy an iron plough or keep it in repair.

It is of the first importance then that the experimental stations should be equipped with an efficient staff, and that the results of their experiments should command absolute confidence. When improvements have been discovered the next question is how to procure their adoption by the cultivator. Various methods are favoured in the several provinces. Some issue agricultural journals; others supply matter to the native press; in some provinces agricultural associations have been established in large numbers, under official inspiration; in others a more cautious procedure is adopted, and it is proposed to postpone the development of associations, until the department is in a position to afford them the assistance of trained officers. Other measures taken are: the encouragement of agricultural shows; the cultivation of demonstration plots in selected villages; the conduct of excursions of villagers from outlying tracts of similar character to the experimental farm; and the despatch of itinerant inspectors to lecture and to demonstrate in distant villages.

Illustrations of the various methods adopted could be given from the valuable work done in Madras on sugar-cane and groundnut; in the United Provinces on wheat; in the Central Provinces on cotton; but I will confine myself to a few instances which came under my personal notice in Bombay.

The sugar-cane cultivation at Poona is of the highest character in India, and will bear comparison even with the cultivation of Mauritius. While in Upper India the average outturn of raw sugar is about $1\frac{1}{4}$ tons per acre, in Poona, with the aid of ample irrigation and supplies of manure as much as six tons have been obtained, and an outlay of £20 per acre on fertilisers has brought in an equal sum of net profit. A discovery of far-reaching importance has here been made that oil-cakes will supply the nitrogen required for this crop at the cheapest possible rate.

Parties of cultivators from the canal districts of the Deccan have been taken to see these results, and the keenness of their interest was evinced by the severe cross-examination to which they subjected the farm staff in regard to all the methods and manures employed.

Again, at Dharwar, though the farm has only been started three years, a useful local improvement has been shown to the people. The tract is infested with a deep-rooted grass weed which could only be kept in check by the expensive process of hand-digging. It was demonstrated that an iron plough could clean the fields at a fraction of the expense, and could be drawn by the local oxen. Large landholders came from all parts of the district to see the tests, and being satisfied of the economy, purchased a number of the ploughs.

On the Deccan canals, where the experience of the Poona Farm enables definite recommendations to be made with confidence, itinerant inspectors have been sent out to tour, with instructions to warn the villagers of the dangers of over-irrigation and waterlogging; and to advise them as to the manuring of sugar-cane. These tours proved a great success in attracting the interest of the best classes of cultivators, but so far only two men could be spared for the work. It is essential that such men, if they are to overcome the distrust and scepticism of the villager, should be tactful and experienced, and have a thorough working knowledge of their business. The premature despatch of inefficient youths on this duty would only bring the department and all its works into derision, such as was excited some time ago by a circular issued by an amateur agricultural association, in which farmers were recommended to fertilise their fields by killing mad dogs and burying their carcases.

Past experience has proved the danger of the recommendation of untested improvements. During one famine large quantities of carrot seed were imported, as a sure and rapid source of food; the precious remnant of moisture in the river beds was exhausted in a vain attempt to grow carrots, where the indigenous millet would have given invaluable relief. Drought-resisting tapioca cuttings have been imported from the West Indies, where no drought is known comparable to an Indian drought, in ignorance of the fact that tapioca abounded in India; drought-resisting grasses from Australia have been widely distributed and have been found to grow with success only on the margin of

running streams; windmills have been imported in numbers in tracts where the wind was either excessive or too capricious for utilisation; and the failures of foreign machinery have been innumerable.

These cases exemplify the negative benefits that may be expected from the new department. It is something gained to have a safeguard against the commission of such errors in future. From the same point of view the Bombay Government require every officer of the Indian Civil Service in their employ to study the elementary problems of Indian agriculture during a short course at Poona. The knowledge thus acquired will not create an agricultural expert, but will enable the officer to avoid egregious mistakes, to win the confidence of the people by an intelligent sympathy with their difficulties, and to act as a link between them and the department.

From these dry administrative details let us turn to the chief products of India and take a brief survey of some of the questions under investigation. The department are somewhat bewildered with the multitude of problems pressed upon their attention, and are fortunate that in seeking to concentrate their efforts on definite points of the greatest urgency they have the support of the Royal Society here in London, who have most generously placed their advice and assistance at the service of the Government of India. Cloves and nutmegs have their own allurement for the specialist, but sugar and wheat are of greater importance to the country. If we are to view these conflicting interests in their proper perspective, a few statistics are indispensable, but as some apology for their introduction let me assure you that they are mere approximations and have no claim to precise accuracy.

Sugar.

We will take sugar first, for not only is it the typical product of India from the dawn of history, but it presents to-day every variety of unsolved problem for scientific enquiry.

India is the undisputed parent of the sugar-cane cultivation of the world. The Greeks mention with astonishment how they saw honey made by the hands of men; the Arabs carried it to the Mediterranean and Spain, and at the famous College of Natural Sciences, at Jundisapur, invented the art of sugar refining. Until the fourteenth century, in this country, we knew no source of sweetness other than honey, and the first recorded imports of sugar took place in 1319, when fifty tons were received from Venice, and were sold at the price of 1s. 9d. per lb., or the equivalent of 21 shillings of our present currency.

In former days, India exported sugar; now she imports, roughly, a quarter million tons of refined sugar, valued at about £4 million sterling. The demand which has arisen for refined, in place of unrefined sugar, cannot as yet be supplied by sugar factories in India. Sugar and sweetmeats are the Indian equivalent for the English glass of beer, and consumption increases with prosperity. It is satisfactory to note that the output of raw sugar is still twenty times as great as these imports, that the price has not been reduced by foreign competition, and that in those British provinces where alone comparison is possible, the statistics show no decrease in the yield.

There is no crop regarding the cultivation, harvesting, and manufacture of which agriculturists, European and native alike, have so little certain knowledge. The number of varieties with distinct characteristics is very great: some require ample irrigation and contain a high percentage of sugar; others will grow with a minimum of moisture, but give a reduced outturn; others, again, are preferred for the hard fibre which resists the attacks of jackals and wild boar. The entomologist studies devices for circumventing the white ant and the sugar-borer pest; the mycologist investigates the red-rot fungus (*Colletrochicum falcatum*); while the chemist is required not only to advise on the comparative value of fertilisers, but also to determine the period of ripening, and the sugar content of different varieties. If sugar is to be refined, the aid of the chemist is also required in the further processes.

In all these matters much work has already been done, but much more remains. Though canes have been imported from all sugar-producing countries, the distribution to each tract of the variety best suited to its conditions is far from settled. A great impediment to the industry is the inefficiency of the mill for expressing the juice; in the United Provinces, where thorough experiments have been made to reduce the cost of the native methods of treatment, the conclusion is that the establishment by private enterprise of agencies for the sale, hire, and maintenance in good repair of cane-mills, boiling-pans, and centrifugals is the greatest need of the industry.

Wheat.

Wheat covers an area in British India of some 25 million acres, and has an outturn of

some 7 million tons, and a value of £42 million sterling.

The varieties cultivated are exceedingly numerous and differ greatly in quality. Many spasmodic attempts have been made to extend the cultivation of the superior soft varieties but with little success, for they either refuse to grow or deteriorate rapidly. The yield is estimated to average 5 cwt. or 9 bushels per acre —an outturn similar to that recorded in England 500 years ago—but with irrigation and manure it rises to 15 cwt.

In certain tracts where cloudy weather is apt to induce rust, only the inferior varieties which are resistant to this disease can be grown. Hopes are entertained that by hybridisation varieties may be obtained which will combine this resistant power with a superior quality of grain; and systematic investigation is being conducted to ascertain by selection the most profitable variety adapted to each soil and climate.

Jute.

Jute has recently come into the front rank of Indian industries. The great increase in the demand for fibres has doubled its price in the last five years, with the result that the area cultivated has risen in that period from two to three million acres, and the crop in 1906 was estimated to be worth £35 millions sterling.

A hundred years ago it was an unknown commodity to the markets of the world, and was only used as the material for the coarse sackcloth worn by the peasants of Bengal.

The cultivation is still restricted to the provinces of Bengal and Assam, but efforts are being made to introduce it to other provinces. A survey has just been made of all tracts in India which appear to be suitable to the crop, and skilled cultivators from Bengal were despatched to conduct experiments on the agricultural stations. In its original home jute ripens in three to four months with a rainfall of thirty to forty inches and a soil of sandy loam. It may be sown in March, April, or May, and harvested in July and August. Some sixty varieties are known to Bengal, and several alternative roads to success offer themselves for investigation. Areas may be found with climatic conditions similar to those prevailing in Bengal; irrigation from canals may prove an efficient substitute for rainfall; or varieties may be discovered which will adapt themselves to different soil and scantier moisture. The large outturn and high value of the crop is an incentive to perseverance in these researches, for while cotton on an average will yield less than a cwt. of lint to the acre, worth, say, a couple of pounds, jute will produce 10 cwt. of fibre worth about 12 pounds.

Cotton.

To turn once more to cotton. The statistics tell us that if we include Native States, cotton covers an area of 20 million acres, and produces about 4 million bales, of an approximate value of £30 million. Very little of this comes to England (about 100,000 bales, worth £$\frac{3}{4}$ million); and since the whole of the rest of the British Empire produces less than 20,000 bales, Lancashire pays some £52 million sterling annually to foreign countries for its supplies.

There are bold men who assert that it is proved by the Indian hand-loom weavers of Dacca that Indian lint is capable to-day of weaving the finest qualities of cloth—and this not from a vanished species of tree cotton as an exploded myth used to declare, but from the ordinary coarse Bengal staple—and that great discoveries are yet possible in the region of electricity and humidity to adapt modern machinery to the use of short staples. Certain it is that during the American Civil War, when Lancashire was starving for the want of 6 million cwt. of American cotton, India came to the rescue and succeeded in increasing the exports to Lancashire by 5 million cwt.

Bombay, the Central Provinces, and Berar contain three-fourths of the cotton area. The better classes of cotton require a longer period of growth than the brief seasons of rainfall in India permit. Except where the soils are extraordinarily retentive of moisture, length of staple depends chiefly on the dates when the monsoon begins and ends. Thus the Khandesh cottons which are sown in June and harvested in October have a staple of about half-an-inch; the cottons in Broach and Dharwar sown in August and harvested in March, have a staple of three-fourths of an inch, and are 30 per cent. more valuable.

The failure of the constant efforts to introduce American and Egyptian varieties, which flourish most favourably with a season of growth extending up to eight months, resulted in most cases from the want of sufficient moisture in the soil for this length of time. In Upper India a further difficulty was added in the injury caused by the frosts, which are liable to occur in December and January. Thus in that region nature appears to demand that

these plants, if grown at all, shall be grown between February and November.

This important conclusion was grasped by an officer of the Bombay Department of Agriculture who had studied the cultivation of Egyptian cotton in Egypt, and has led to the successful introduction of this valuable variety into Sind.

Sind closely resembles Egypt in almost every point. It is practically rainless, and derives its life from the Indus as Egypt from the Nile; in area of cultivation it is rapidly increasing, and may before long rival Egypt. Until recently all cultivation has depended on the inundation canals, which fill with water only when the snows in the Himalayas begin to melt in May, and which dry up with the cessation of the flood in October. With this brief season the Sindhi peasant has been compelled to grow a cotton which comes rapidly to maturity and necessarily possesses a short staple. Within the last few years the skill of the engineer has supplied two of the chief canals in Sind with a perennial flow of water, and has revolutionised the agricultural conditions on 700,000 acres, or one-fifth of the province; and yet more magnificent projects are under consideration.

In March, 1904, the department planted 20 acres of Egyptian cotton, and in November obtained an excellent yield both in outturn and quality. In 1905, 500 bales were produced by native landholders; in 1906 and 1907 this quantity was doubled. The experiment has been seriously checked by an unprecedented attack of boll-worm, which damaged the indigenous and exotic varieties alike; and by the conscientious objection of the Sindhi cultivator to apply the greater amount of labour that is necessary to the cultivation of the superior fibre. But a confident expectation is entertained that eventually Sind will produce 100,000 bales of almost the finest cotton in the world, worth at least twice as much as the indigenous variety.

The Western Punjab is closely allied to Sind, and if success attends the efforts that are in progress to acclimatise Egyptian and American varieties there, the irrigation colonies offer a vast field for their cultivation. But in addition to the substitution of superior varieties for inferior in these exceptional cases, there is much useful work to be done in various directions.

In some tracts, as in Berar, where cotton cultivation is increasing rapidly, and the people have little agricultural skill, demonstrations of the advantages of sowing in furrows instead of broadcast, and of intercultivation, have proved of value; in tracts, such as Broach, where no improvements can yet be suggested in cultivation, it is believed that hybridisation and selection of seed may improve the indigenous stocks; and everywhere there is imperative need of the assistance of the entomologist. Few plants have a more arduous struggle for existence against the ravages of insects than the cotton. As the season goes on, its enemies multiply; if climatic conditions favour the propagation of insects and retard the maturity of the cotton-boll, the result will be disaster.

The most destructive pests are the boll-worm, the red cotton-bug, and the aphis. Fortunately, India does not possess the American cotton-boll weevil, which has exterminated the cotton plant from large areas in the United States, and which in 1905 was computed to have caused the loss of cotton to the value of £4½ millions. Protective action has not before been taken in India against the importation of plant diseases, and the measures which now enforce the fumigation of consignments of American cotton seed may be placed to the credit of the new department.

In regard to insect pests, the native cultivator is remarkably ignorant and entirely helpless. Many simple and efficacious remedies have been suggested by the Imperial entomologist, the general adoption of which would be of immense benefit to agriculture.

Before I leave the subject of cotton, I may refer to a fact of some antiquarian interest to this Society. Within the last few years there has sprung up a large export of cotton seed to England, amounting last year to 220,000 tons. An edible oil is expressed, and the residue, sold as Bombay cotton cake, is a cheap and valuable food for cattle. Thus there has recently been carried into effect an industrial project which was recommended by this Society 120 years ago, when in the year 1785 it offered a premium for a machine which would convert cotton seed into oil cake.

Food Supply.

The fear is sometimes expressed in India that the increase of population will shortly overtake the supply of food-crops in the country, and alarmists point with apprehension both to the exports of wheat and rice, and the increasing cultivation of fibres, oilseeds, and other non-food crops.

Great changes are occurring in rural economy

and vast vistas of speculation open before us. The rise in the prices of agricultural produce demands enquiry. Is it due to temporary or permanent causes? and what will be the effects? In Eastern Bengal, we hear of the prosperity induced by the boom in jute raising the standard of comfort, and thus reacting on prices. If enhanced prices lighten the burden of the obligations of the farmer, what of the labourer and other sections of the community? Will the plague improve the position of the labourer, as the Black Death did in England? Not only in areas stricken by the plague, but in industrial centres, and irrigational colonies, complaint is made of the dearth of supplies of labour.

No man will be so rash as to maintain that the agricultural future of India is free from peril, but this at least may be said that whatever dangers may be in store, would only be enhanced by any attempt to interfere with the freedom of action of the cultivator. Nor do the statistics support the view that India is within measurable distance of the catastrophe of a shortage of food-stuffs; 185 millions of acres in British India are under rice, wheat, millets, and pulses, and far more than suffice to feed the 240 millions of people dependent thereon,

A few years ago Lord Curzon, investigating the larger question of the expansion of cultivation as a whole, found that in the previous twenty years it had kept pace with the increase of population. At the same time Lord Curzon was led to emphasise the importance of the development of the irrigational resources of India "as the most efficient factor in the increase of agricultural production." At a later date he would surely have coupled with irrigation the application of science to agriculture. We know already that systematic observation and scientific experiment can suggest improvements, and we can judge of the effect of the smallest improvement if it can be applied over an area of 185 million acres.

Oilseeds form another important division. Sesamum, rape, mustard, linseed and groundnut had last year an area of 14,000,000 acres, an outturn of 2 million tons, and a value of £20 million. The examination of these crops can scarcely be said to have begun, and the possibilities of improvement cannot yet be gauged.

Minor Products.

We must leave on one side the numerous minor products of India; the spices and gums which were the earliest attractions of the merchant adventurers; the lesser or more speculative fibres such as hemp and agaves, in which men seek substitutes for cotton, jute and silk; narcotics and drugs, such as opium and tobacco, the battle-ground of philanthropists and physicians; the dyes, starches, vegetables, and fodder-plants, each of supreme interest to their enthusiasts; and we will just touch on tea and indigo which merit attention, as being the admitted products of English enterprise.

Tea covers an area of 500,000 acres, almost wholly in Eastern Bengal and Assam, and has an outturn of 2 million cwt, and a value of £6½ million. A remarkable feature of this industry is that within the last five years while the area cultivated has been stationary the production has increased by 25 per cent., and tea-planters ascribe no small share of this great improvement to the researches of the scientific staff entertained by the Calcutta Tea Association, and to the widespread adoption of their suggestions as to the treatment of the gardens.

Indigo has long been a subject of sorrowful interest in this country. In its present state of decline the cultivation extends over an area of only 450,000 acres, mostly now in Madras, and the production amounts to 70,000 cwt. valued at less than £1 million.

The dawn of brighter hopes deserves mention. New varieties of the plant have been introduced from Java and Natal, and give a superior yield. Discoveries made at the research station established by the Behar indigo planters and the Bengal Government, are reported to have improved the manufacture of the dye, and may yet enable the natural product to withstand the competition of the artificial.

Departmental Work.

For an adequate appreciation of the agricultural situation, it would be necessary to put before you a survey of the work not only of the Agricultural, but also of the Forest and Veterinary Departments; for questions of afforestation and cattle are intimately concerned with the efficiency of agriculture. The utilisation of valuable manurial supplies for fuel continues to be a grave problem, of which the operations of the Forest Department restricted, for the most part, to narrow belts of hilly country, have as yet provided no solution. The control of cattle epidemics is the first care of the Veterinary Department, and the education of native agency is receiving attention in the old-estab-

lished colleges of Bombay and Lahore, and in new colleges in Madras and Bengal. In forestry, there is a single centralised institution at Dehra Dun in the sub-Himalayan tract.

The several departments work under the orders of the Provincial Governments, and their programmes are criticised by the recently-created Board of Scientific Advice, who issue an annual report of their proceedings. For a more complete account of the work of the Agricultural Department, I must refer all who are interested to the excellent publication issued by the Pusa Institute, and entitled "The Agricultural Journal of India," and especially to the summary contained in the number for July, 1907, of the proceedings of the last conference of the Board of Agriculture.

Amongst the fundamental problems undergoing investigation at the Pusa Institute, we find the fixation of nitrogen by plants and soil inoculation for the purpose of increasing the bacteria; but the study of fermentative changes both in the soil and in the plant is still in its infancy, and the experiments at Pusa and at various provincial stations were alike unsuccessful.

Chemistry.

In chemistry the work has included: the determination of available plant food in soils, and of nitrogen compounds in rain and dew; the examination of soil drainage and of the quantity and movements of soil moisture; and the investigation of poisonous elements in certain roots, seeds and fodders.

The chemical branches of the provincial departments are concerned with local problems of drainage and the supply of fertilisers for different classes of soil.

The drainage question is of great importance where large areas are impregnated with alkali salts, and where the new irrigation canals, whether winding through the hills and dales of the Southern Peninsula, or rolling in vast volumes over the sandy deserts of the north-west, raise the water-table with their percolation, and seriously modify the physical texture of the fields.

The introduction of artificial fertilisers has hitherto been believed to be prohibited by their cost; but this view may require reconsideration in the light of more accurate knowledge of the needs of Indian soils, the increase in value of various crops, and the possibilities of the future derivation of nitrogen from the atmosphere by cheap electrical methods. It has been ascertained that of the three chief manures, nitrogen, phosphates, and potash, the first, nitrogen, is far the most beneficial to Indian agriculture, phosphates and potash being already present in sufficient quantities in many soils. The questions to be solved are by no means simple. The conditions of each definite tract must be considered in order to determine: firstly, the most favourable source of the nitrogen required; *e.g.*, whether farmyard manure, fish, oilcakes, or perhaps, importations of nitrate of soda or sulphate of ammonia; secondly, what is the most profitable amount of nitrogen to apply; and finally, what crops will repay the use of the fertiliser; there will be no doubt about intensive garden cultivation, sugar-cane, or irrigated crops of high value, but with dry crops, such as cotton and millet, much caution will be needed, or the crop may actually be injured in the event of drought.

Botany.

In botany the first essential is the identification and classification of the plants under enquiry, for great confusion has resulted in the past from the want of an uniform nomenclature. The magnitude of this task may be gauged from the fact that at Poona, where it was initiated, in a single season over 1,100 varieties of plants from all parts of the Indian continent were grown and tabulated with minute care. To the botanist is assigned not only the determination of varieties suitable to different localities, but also the development of plant-breeding.

America has taken the lead in preaching and practising the gospel of hybridisation, and f its theories are not acceptable to the older school of botanists in this country its practical benefits are undeniable. In India useful work has already been done in crossing varieties of wheat and of cotton, and improvements of stocks are confidently expected by the expert staff of each province.

Entomology.

In entomology and mycology progress cannot be equally rapid. It has been decided that no European scientific officers are at present to be attached to the provincial departments; and the duty of observing the insect pests and fungoid diseases of the whole continent rests on the shoulders of two entomologists and one mycologist at Pusa. It is contended that the economic value of mycological studies has not yet been established in the eyes of Western scientists, but I am not aware whether a scep-

tical attitude is also adopted in regard to entomology. There is in fact no branch of agricultural work which affords greater promise of valuable results than entomology. The scientific study of insect life is a new idea to the Eastern mind: even the most skilful cultivators are profoundly ignorant of the life history and habits of insects. Thus they mistake beneficial for injurious insects and destroy their best friends; when the sorghum suffers from attacks of the aphis, and the ladybird comes to eat the aphis, the ryots destroy not the aphis but the ladybird.

When the locust and the grasshopper lay eggs in myriads in their fields, they refuse to believe in the existence of the eggs and make no attempt to plough or dig them up; and when the pest developes, they regard it as the visitation of some incensed deity.

In Western India, which is periodically afflicted by the depredations of locusts, entomological enquiry recently saved the Government from heavy expenditure on impracticable measures, and placed their administrative policy for the first time on the sure basis of knowledge.

In regard to the action of certain insects, opinion is as yet divided; take for instance the termite, commonly known as the white ant. Some people maintain that it never attacks healthy living tissue, and is the cultivator's friend in turning up the soil, and improving its texture; others support the native view that it prohibits the cultivation of such crops as sugar-cane in certain districts, and can only be kept in check by profuse irrigation.

I have already referred to the numerous pests of cotton, to the attacks of which so many exotic experiments have succumbed. Last year, a campaign was conducted against the bollworm, which had devastated the indigenous cotton of the Punjab; it was believed that a parasite, the natural enemy of the bollworm, had been killed off by abnormal frosts, and measures were taken to re-introduce this parasite. It is reported that these measures were remarkably successful, and the conclusion may fairly be drawn that not only for the introduction of imported varieties, but also for the preservation of indigenous stocks, the aid of entomology is indispensable.

Irrigation.

I hope that these notes may suffice to convince the unprejudiced critic of the potentialities of advantage to the people of India contained in the new agricultural policy; but I am aware that strong-minded friends of mine refuse to be led astray by the dreams of enthusiastic fancy and stand firm in the ancient tradition that the interference of Government in agriculture is, has been, and must always be pernicious.

Since, however, even these "irreconcilables" admit one exception to this principle in the case of irrigational agriculture, let us consider for a moment the value of this concession. If we refer once more and for the last time to the statistics, we learn that of a total area annually cultivated in British India of 226 million acres, over one-fifth part is irrigated from canals, wells, or tanks; and of this area of some 45 million acres, 10 million acres have been brought under irrigation from canals which have been constructed by the State within the last thirty years.

Now, the precarious character of the rainfall is the greatest curse of the Indian cultivator, and a regular supply of water is the chief burden of his prayer. Vicissitudes of drought and flood (and mainly drought) in many tracts threaten his very existence, and everywhere hamper his prosperity and impede the improvement of his cultivation. It is idle to talk of the proper rotation of crops and the value of the selection of seed to a man who is compelled to determine according to the exigencies of each season what crop is likely to come to maturity at all, and to return him a bare subsistence for his labour. Thus, over large areas he will prefer cotton or millet according as the early rainfall of June is scanty or plentiful, and at the last moment open for his choice he will have recourse to the village store, and accept from the trader the remnants of a weevil-eaten seed-bin. His skill and courage in securing a catch-crop in the face of heart-breaking calamities have won him the respect and admiration of all competent judges, but in these sterile regions what hope of improvement of his lot is offered to him by Nature?

It is only in recent years that this question has been seriously taken in hand by Anglo-Indian engineers, but the progress made has been little short of marvellous. Their pre-eminence in hydraulic engineering is cordially recognised throughout the world and needs no commendation here. The conditions with which they have contended have varied greatly; in North-Western India the snows of the Himalayas constitute an inexhaustible reservoir and give a constant supply to the

rivers from which canals have been conducted into deserts practically devoid of rain. In Southern India, the rivers starting from the low ranges of the Western Ghats are fed only by the capricious monsoons, and the main canals are either confined to the deltas in the Madras Presidency, or are dependent for their storage on artificial lakes of immense size.

Wherever it has been found possible to construct these canals, agricultural conditions have been revolutionised. Millets, pulses, and short-stapled cotton have given place to sugar-cane, wheat, rice, spices, and oil-seeds.

The traditional lore of the ryot is no longer of any avail; he must learn the methods of cultivation of crops, of which neither he nor his ancestors have had any experience; and the mistakes which he makes are a powerful factor in preventing the full utilisation of the water placed at his disposal. As the man who has never handled a sovereign cannot administer with wisdom a sudden fortune, so the ryot, accustomed to scanty falls of rain, does not know what to do with the streams that permeate his land in copious abundance. He cannot understand that excess of water may be injurious. Over-irrigation exposes his wheat to attacks of rust, damages the quality of his sugar and the fibre of his cotton, and want of drainage renders his fields infertile from water-logging and the rise of alkali.

Here, then, we see a wide scope for the energies of the new department. It is computed that the produce of an acre of irrigated land is in many districts equivalent to the produce of three to four acres of dry-crop land, and the value of the crops grown under irrigation must be a large percentage of the total agricultural wealth of the country. The Government of India is committed to a programme of great magnitude in further irrigational expansion; tracts of country larger than the whole cultivated area of Egypt will shortly be traversed with a network of new canals; the success of these canals and the continuance of this policy will be greatly influenced by the skill and rapidity with which the cultivators adapt themselves to the new systems of agriculture required. In facilitating this change, the Department of Agriculture can play a great part, and I venture to submit that even if those hard-headed sceptics to whom I have referred dismiss its other activities as visionary, and regard it solely as the handmaid of irrigation, they will be compelled to admit on this score alone it will fully justify its existence.

DISCUSSION.

The CHAIRMAN (Sir James Monteath), in opening the discussion, said that possibly some of the author's views might not escape valid criticism, but personally he was generally in accord with what had been said, subject to very slight qualifications on points of no general importance. The school which held that the interference of Government for the improvement of agriculture in India was pernicious, and that the Indian cultivator knew all that was worth knowing about the cultivation of his crops, could not now be very large or very influential. He did not understand how any one who had seen much of the country could say that Indian agriculture was, on the whole, efficient. It was true that in many places cultivation of a high order would be found, and that was especially the case where water was available, although cultivators who held land adjacent to canals might require guidance in respect of some of the matters referred to by the author. Great skill and industry were shown in raising water from natural resources, and in the methods of utilising it. The spice gardens, for instance, in Kanara were worked with marvellous ingenuity; they were carried on in the middle of the jungle, and under circumstances in which Western agriculturists would be very much at a loss. There were instances everywhere of the richer dry crop land being cultivated carefully and successfully, and that was generally the case with rice lands, but the great bulk of the agriculture was manifestly not what it should be. The great defect was the insufficiency or entire absence of manure. People who were living amongst wooded hills found that they could get a crop of coarse grains merely by burning down the jungle and sowing seed in the ashes, or afterwards by indiscriminately cutting wood, carrying it to suitable bare places, and burning it there. In that way whole hills, perhaps most of the hills in the Deccan, had been entirely denuded, much to the detriment of the climate. Even at the present time that practice was not entirely stopped, although it was prevented as far as possible. What might have been valuable sources of manurial supply, as well as of fuel, had thus been entirely destroyed. Then there were large areas which were not touched by the plough more than once in three or four years; in other years in which the crops were sown they were merely scratched with a harrow, and one very often found the crops quite choked with weeds and grasses. But even in cases in which the cultivation was carried out fairly carefully and successfully there was little doubt that there was much room for improvement in the fertilisation of the land, or in the substitution of more valuable crops, or more valuable forms of the crops already grown. In his opinion the agricultural resources of India which were still undeveloped were enormous. There was, perhaps, no country in the world in which efficient agriculture was more essential for an advance in prosperity than India. The great bulk of the

people depended upon cultivation with their own hands for their daily bread. The artisans in the villages almost all had their own plots of land which they or their families cultivated as a help to their subsistence. The people who went to the towns to work in mills or in other industries, as well as those who enlisted in the army, or in the police, generally had lands which they left their families to cultivate, and to which they looked forward eventually to return. Also, outside the capital towns it would be difficult to find a native professional man or a trader, or even a Government servant, who did not own some land. It would probably be well if it were otherwise, if only a certain number devoted their own energies to cultivation, and the rest confined their attention to other pursuits. But as it was, there were very few members of the community who would not profit directly and immediately by an increase in the production of land which they themselves cultivated, or in which they held an interest. Unfortunately, as Mr. Lawrence had pointed out, men of means who had property in land generally—there were exceptions somewhat rare—confined their concern with it only to the realisation of their rents. There was little hope of any substantial improvement unless Government supplied the means of experiment and research. The legitimacy of that expenditure seemed to him beyond question because, after all, Government was the principal landowner. In his opinion, no greater service could be rendered to India than by devising means for the development of its agricultural resources. It would be a mistake, however, as the author had pointed out, to suppose that Western methods could be forthwith applied to India. It had fallen to his lot in the early seventies to examine into the results, financial and otherwise, of the principal of the four experimental farms then in existence; they were called, at that time, model farms. He found that abundant crops were produced, but they were produced by methods which were entirely beyond the means of the ordinary cultivator. And not only so, but in most of the individual cases the value of the increased outturn did not cover the increased cost. Of course, an experimental farm could not be expected to pay, for many experiments must be unsuccessful; but it was no use to show a ryot how he could obtain an increased outturn unless it was at the same time demonstrated to him that at least a fair share of the increase would be clear profit. But all this was now fully appreciated, and the English expert now recognised that his first duty was to study the existing agricultural conditions and methods, and his hope was that experiment with scientific knowledge would enable him to introduce some modification of the methods which would be fruitful, rather than introduce entirely new methods. In most cases the capacity of the small cultivator must be the standard by which improvements must be regulated. There were, of course, exceptions, as the author had pointed out. Large capital was made available for extensive sugar plantation near Poona, and in other cases where it could be shown to be well worth while. But ordinarily the first consideration must be whether, in the conditions existing, an improvement could be general, or at least far-reaching; and no improvement could be far-reaching unless the small cultivator could adopt it. If in these circumstances rapid progress could not be expected, there was this to be said, that, if a single improvement did become general, or was even very extensively adopted, the result would probably justify the whole of the expenditure. If, for instance, by hybridizing long staple cotton or a soft wheat could be adapted to the climatic conditions, the benefit to the country would be immense, and that benefit, at any rate, would also extend to this country. He thought, however, it was not the case that past operations had been entirely valueless except for the negative benefit to which the author had referred, namely, showing what should not be repeated. Even the old farms did considerable service by distributing good seed, and the effect of the introduction of American seed into the southern Mahratta country had not yet entirely passed away. In Bijapur and also in Belgaum, as well as in Dharwar, there would be found what was called vilayati cotton growing side by side with what was now called indigenous cotton. The former, he took it, was the progeny of the imported American seed, and the ryot still recognised that its value, if the season happened to be favourable, was greater than that of the indigenous variety. It is known in the market as Kumpta cotton, because before the railway days it was sent through the port of Kumpta, in Kanara, and, at any rate, not very long ago held a high position amongst cotton exported from India. The author had said that before 1902 there was not a body of agricultural experts. He thought the author had laid stress on the word "body," for, as he was aware, two able members of the Bombay Civil Service in the eighties went through the full Cirencester agricultural course, and afterwards held appointments in which they could utilise their training, and the present Inspector-General was employed with great advantage in Bombay before 1902. The Bombay Government, in fact, so long as he (the Chairman) had known it, and long before, had fully appreciated the very great desirability of adopting measures for the improvement of agriculture, and had done what had seemed practicable at the time: but until 1902 had not the means of doing much. The great drawback was the want of manure. The almost universal use of cow-dung for fuel seemed to the ordinary observer a most lamentable waste. He was aware that it was stated on good authority that the ashes contained fertilising elements in an active form, but the ashes could not go far. He thought the author was right in saying that the Bombay Forest Department had not yet found a solution of the difficulty. It was doubtful, however, whether the supply of firewood at convenient centres would of itself be an effective

solution just at the present moment, because even in the midst of the jungle the people preferred cow-dung to wood for fuel, presumably because it burned more slowly, retained the fire, and so saved trouble, a very powerful consideration in India. In his opinion, however, there was very great scope for the energies and the persuasive powers of the Agricultural Department in that matter. It was not beyond hope that large numbers of cultivators should be made to realise the very great benefit of making proper use of their farmyard manure, and he did not even see why they should not be gradually induced, for the sake of this benefit, to grow fire-wood on the borders of their own lands. Meanwhile it was satisfactory to learn that there was a chance of cheap fertilisers being adopted. The discovery that oil seed contained a large amount of manure was very important, because oil plants were very extensively grown. Many large quantities of bones were exported instead of being kept for use in the place where, perhaps, they were more needed than anywhere else. He did not see why there should not be eventually simple bone crushers in every village. He imagined that some of the cultivators would have at first some prejudice against the use of bone dust, but he thought that prejudice would undoubtedly give way to self-interest if it were clearly demonstrated to the cultivators that there would be great profit in using it. Altogether it seemed to him that measures for the better fertilisation of the land afforded a more promising field for the beneficial action of the Agricultural Department than any other, although he agreed that entomologists and mycologists might save enormous loss by devising means for the destruction of insect pests and fungi.

Lord Reay, G.C.S.I., G.C.I.E., said he had followed the paper with the utmost interest. He had always considered that there was hardly any department in the public service of India of greater import-than the Department of Agriculture, and when he had the honour of being Governor of Bombay, when the appointment of Director of Agriculture had to be filled, he took very good care, and he had no doubt that his successors did also, to see that it should be filled by one of the best members of an excellent service. He congratulated Mr. Lawrence on having held the appointment so long, and on having made such good use of his time. When he heard Mr. Lawrence speak of the sugar cultivation in the neighbourhood of Poona, he remembered, and the Chairman would also remember, that they had to deal with the influence of this cultivation on the sanitary condition of Poona. The Chairman was well aware of the great difficulties which had to be met on the one hand in giving encouragement to the sugar cultivation, and on the other in preventing results which were injurious to the due observance of hygienic precepts. In his reply Mr. Lawrence would perhaps mention whether that difficulty still x isted or whether it had been overcome. At the time when he was Governor of Bombay, the question of long staple cotton was one of the questions that was being looked into, and he was delighted to hear from the author that in Sind the cultivation of long staple cotton had met with success. Another point which he was very glad to notice was the extension which had been given to perennial irrigation in Sind. That had been one of the questions with which he had had to deal, and he believed the author, when he went back to Bombay, would find in the archives a paper written in the last days of his (Lord Reay's) governorship, in which proposals were made with regard to a large increase of perennial irrigation in Sind. He endorsed everything said in the paper with regard to the importance of irrigation. With reference to agricultural education, he was also pleased to hear that the number of students at the College of Poona was on the increase, because it was of the utmost importance that the number of those who entered for agriculture at college should be increased. With respect to experimental farms, he did not think that the experiments ought to be discouraged, but a distinction ought to be made. On the one hand, there were experiments made from a purely scientific point of view which might be of great importance; and, on the other hand, there was another category which might be called demonstrations. From the paper, he gathered that the Department, in various localities, was now undertaking demonstrations. He thought that was of great importance, because, as the Chairman pointed out, what one had to prove by demonstration was not only that the improvement would result in better crops or better cattle, but one must also prove that if there was any additional cost that cost would be recovered by a better return. That applied not only to India, but to this country. He congratulated the Agricultural Department of India that they had not to deal with the great question which occupied the Agricultural Department at home, namely, the creation of small-holdings; he thought India might be called the paradise of small holders, and that everything which was done for agriculture must benefit the small holder. In Europe, of course, the best way in which the success of small holdings could be assured was by co-operation. At present co-operation in India was not, he supposed, very general, but some day he thought a solution of many of the difficulties with regard to Indian agriculture might be solved by co-operation. He should like to know whether the Agricultural Department had taken any steps to promote co-operation. Another matter in which the Department might give guidance was with regard to securing good bulls and stallions. That would certainly be appreciated by the farmers. With reference to education, he thought credit ought to be given to His Highness the Gaekwar of Baroda. Baroda was, if he was not mistaken, the first native State where, in the College, an agricultural chair was created. The first holder of that chair was

a distinguished gentleman, Professor Middleton, who afterwards was Professor of Agriculture at Cambridge, and at the present time was Assistant Secretary at the Board of Agriculture. He did not think there was the slightest need to enter upon the question whether the interference of Government in agricultural matters was legitimate. If there was a field in which the interference of Government could be of the greatest value to the greatest number of His Majesty's subjects in India, it certainly was in regard to the improvement of agriculture. He should rather say—and it applied to this country—that hitherto not enough had been done in that direction. He thought Lord Curzon deserved the greatest credit when he, in 1902, made use of the fortunate financial condition existing at the time, by giving to the Department of Agriculture further means of extending its operations. He also agreed with Mr. Lawrence as to the great importance of entomology. The author had not alluded to agricultural banks and agricultural indebtedness. He believed that agricultural banks had been started in India. He should also like to ask whether the question of the extension of the Deccan Relief Act had been considered lately, as it was a question which in his day had been carefully considered by the Government.

Sir Thomas W. Holderness, K.C.S.I. (Secretary of the Revenue Department, India Office), associated himself with Lord Reay in thanking Mr. Lawrence for his admirable paper. He thought one of the peculiar excellencies of the paper was the historical setting in which the author had put his description of agriculture. He had shown very clearly that India had been changing immensely during the last 100 years; and those changes had affected agriculture in innumerable ways, so that the time had come for an improvement. Agriculture was the dominant industry of the country, and it was inevitable that more thought and application should be given to agricultural problems. Lord Reay had mentioned the question of the possibility of co-operation in agriculture. He (the speaker) thought that co-operation might possibly develop out of the movement that had been commenced in India for the starting of co-operative credit societies. It was a new movement, and many years probably would pass before its effect could be seen; but officers who had been able to watch the movement were satisfied that it was making great strides. Then there was the question of the present strength of the Agricultural Department, and whether it should be extended or not. He thought, as far as he could see, that extension must come, but he hoped that the extension would come very largely from the education of the native. It was a field for the educated Indian, and one of the functions, perhaps the main function, of the present organised Agricultural Department should be the training of the people of the country.

Mr. C. W. McMinn, I.C.S. retired, said it had been remarked that there were a class of men who were willing to contend that there was nothing to be learnt by the Indian agriculturist from English science, but he had never met such men. There were no better cultivators than some Indian natives; there were none more industrious or capable, within certain limitations, but it was absolutely certain that there were many things they could learn from others. He (Mr. McMinn) did not think that the author had, on some points, given the latest information. When he was in Calcutta, a few months ago, people were extremely excited at the news that, in Sind, cotton had been raised in which the lint amounted to 1,000 lbs. per acre. Everyone who had studied the question as he had done for the last two or three years, must be aware that the great difficulty about cotton, was not with the short or long staple, but because the quantity which could be raised in India was very small indeed. For instance, it would be seen from the official return that the average production of cotton in India was about 30 to 50 lbs. per acre, whereas in America the production was about 260 lbs. If in Sind, with the aid of the canals, to which the author had given such highly deserved praise, Mr. Lawrence himself had seen 1,000 lbs. per acre of lint then he should say that the cotton problem of India had been very largely solved. All were aware that the difficulty of feeding the population of India was getting worse and worse, and it was most desirable that every improvement should be made in agriculture. The author had said a good deal about the great Mogul canals. He assured the author that the great Mogul canals which the Mogul emperors made were now non-existent; there were no such canals for irrigation purposes. The Mogul emperors brought water into Delhi and Akbar for the purpose of irrigating gardens for houses, and in order to supply baths in which their ladies could plunge; as for bringing water for general irrigation purposes, they never did such a thing.

Dr. J. Augustus Voelcker remarked that sixteen years ago he had read a paper before the Society on the same subject as that taken by Mr. Lawrence, and he might perhaps be allowed to regard Mr. Lawrence's paper as the complement of the former. He (Dr. Voelcker) had, in his paper in 1902, ventured to suggest some of the possibilities of improvement in agriculture, and Mr. Lawrence had that afternoon set out what had been done by the Government and by individuals to bring about the improvement. No one rejoiced more than himself to see the changes that had been made, and how great they had been in the interval that had elapsed. The author and he were in agreement on the main points, which were, first, the possibility of change; secondly, the need of Government assistance in effecting the change; and thirdly, the need of English specialists. He also agreed with the author as to the beneficent work of the Government in effecting such improvements as had been brought about. As Mr Lawrence had pointed out, the action of Government in improving the roads, railways and canals of

India had done what no amount of purely scientific work could ever perform. They were also at one in their admiration of the great impetus given to agricultural progress by the presence of Lord Curzon in India. The schemes which he himself had had the honour of doing something in putting forward had more or less been, he ventured to say, approved and had only been waiting the opportunity for development; through the energy of Lord Curzon that opportunity was found, and he thought he might say that they were now on the way to progress. The author had mentioned the amount of money which Government had placed at the disposal of the Agricultural Department, and while he said that it was small compared with what was done in America, it was very handsome when compared with the miserable pittance which the home Government gave to the encouragement of agriculture in this country. Those present had heard how the Government of India had raised first of all a Central Institute for scientific research, and that there were also provincial departments and colleges opened, and that at these institutes there were European specialists, men whose work had been of good service and was likely to be increasingly so. He was inclined to think that the lines upon which the scheme had been laid out were, in the main, thoroughly good. At the same time there were certain dangers, and one of them was, that the scientific men in India might go, perhaps, a little beyond the actual demands of the cultivators. He thought all work done in India should have as its main element the finding out of improvements which could be adopted by the cultivators. When discoveries had been made, one of the most important things to be done was the disseminating of the results of the discoveries, and in that direction he thought a good deal more could be accomplished. So far as it went, the system of travelling inspectors might be good, but it certainly needed further development, and a good deal depended on who the inspectors were. With regard to sugar, that was a subject which called especially for chemical research, although already chemical research had been of great use in increasing the output of sugar in India. With respect to wheat, that was beyond very much help from scientists, except as regards its fertilisation. It was a curious fact that while the author bemoaned the hardness of Indian wheat, and wished to encourage the sending over of soft wheat, people in this country were doing just the opposite, and were trying to find out how soft wheat could be got rid of, and be replaced by hard wheat. He believed, too, that the growth of jute could be extended. With reference to indigo, he thought the cultivators of India had better let it go altogether. As regards the use of fertilisers, and the employment of iron ploughs, he thought the day was still distant when either the one or the other would be extensively called for. In the case of crops which paid a big return, such things could be used with advantage, but not otherwise. The author had raised a question which naturally exercised people's minds. Would the day ever come when English specialists would be replaced by Indian specialists; in other words, would the native become an independent investigator for himself? It was a great question, and it behoved nobody to dispose of it too quickly. His limited acquaintance with India hardly enabled him to speak with any definiteness on the subject, but, so far as he might venture to forecast, he felt that, although a great deal of use might be made of natives in the colleges and institutes in India, it would be in the position of assistants rather than that they would become themselves independent investigators and workers in pure science, and that, for a considerable time at least, the Agricultural Department of India would have to refer to England and elsewhere for guidance in that respect.

Sir GEORGE WATT, C.I.E., M.B., LL.D., thought the paper had been one of the most able and interesting ever read before the Society. There were only one or two observations he would like to make, and these mainly on the botanical issues of agricultural advancement. The author had said that the Mohammedans had carried the knowledge of cotton cultivation from India to Spain. He had given some attention to the subject of cotton, and he was quite sure that that was not the case. They did not go to India for the cotton, for a very important reason, namely, that the Levantine cotton which they carried to Spain, was not the Indian cotton at all, but a much more temperate species than the Indian. By an unfortunate mistake, Indian botanists had called the Indian plant by the name that should be exclusively assigned to the Levantine plant, but the two were perfectly distinct. Another point was with regard to jute. Botanists had a distinct field of work —perhaps not so important as that of the chemist on which Dr. Voelcker had dealt so ably—but still the botanist had an important function to perform in the great question of Indian agricultural reform. Nothing could illustrate that fact better than a study of jute. Dr. Buchanan-Hamilton, in the early decades of the nineteenth century, had written that he hoped the day would never come when the British manufacturers would learn of the existence of jute; it was such a deplorable fibre, that he hoped it would never become known since it might demoralise the commerce of Europe. But jute production and manufacture had, notwithstanding, grown into one of the most important of Indian industries. As an exemplification of the work that devolved on the botanist it might be said that during the years that had passed it had been learned that there were two species, or rather varieties, of jute. On the eastern side of the Ganges and Brahmaputra, the species, *Chorchorus capsularis*, would be found, whilst on the other side the other variety, the *Chorchorus oletorius*, was met with. Any attempt to try and extend the cultivation of jute that disregarded that fact, would utterly fail. There was something in the climate and soil of Eastern Bengal entirely

different from the rest of India. Although those two forms of jute were so near each other that botanists were not sure but that they might be one and the same species, still there was the fact that the cultivation of *Chorchorus capsularis* could not with advantage be carried across the Ganges. Exactly the same thing would have to be faced in regard to cotton improvements. If scientists, and even practical growers, were to advance the interests of Indian agriculture they must not go on the assumption that cotton was always cotton. It must be found out what particular form of cotton was suitable to each locality. In the old experiments foreign cottons were introduced wholesale with disastrous results. He trusted he might be permitted to say that he differed from the Chairman with regard to the meaning of what in India was called *vilayati* cotton. It certainly was neither American nor one of the best cottons in India; it was the worst of all cottons. There was another point to which he should like to refer. The author had stated in the paper:—"There are bold men who assert that it is proved by the Indian handloom weavers of Dacca that Indian lint is capable to-day of weaving the finest qualities of cloth—and this not from a vanished species of tree cotton as an exploded myth used to declare, but from the ordinary coarse Bengal staple — and that great discoveries are possible in the region of electricity and humidity to adapt modern machinery to the use of small staples." He (Sir George Watt) thought that very possibly he was the sole person who had been rash enough to make that statement, and, moreover, was egotistical enough to adhere to it. Even, in spite of all that had been said, he believed the natives of India knew something about the cotton staple which Manchester people were absolutely ignorant of. From time immemorial the natives had used a short staple; in fact, failed to produce the same results with the American long staples. It was not a matter of the past, it was a matter of the present. At the Delhi Durbar he had sold to a number of the visitors at the exhibition held in 1903 a number of pieces of Dacca muslin, quite as fine as any of the old historical samples that were to be found in museums. These had been spun and woven from the indigenous Dacca cotton, not cultivated years before, but the product of that particular year. He was thus inclined to think that the solution of the cotton question of India was not merely one of selecting a long staple, but a closer study of existing stocks and conditions. He did not think Manchester wanted a long staple only. The bulk of the cotton spun in Manchester was not long staples, but medium. A high-class cotton was wanted, and he had little doubt this could and would be attained in India.

Prof. WYNDHAM R. DUNSTAN, F.R.S., desired to add his note to the general harmony of the meeting and agreed that the author had read a most excellent paper. All were agreed that the Government of India was working upon essentially sound lines in regard to the matter, both in equipping the Agricultural Department so as to be capable of conducting experimental work on scientific lines, and also, what was equally important, providing for the demonstration of results to the native cultivator. The Chairman had touched upon what he (the speaker) regarded as one of the most important problems which at present faced the Agricultural Department of India, namely, the question of manure. The author had not specfically referred to the question of green manuring, but he believed that subject was at present receiving attention at Pusa, and he considered that it was in that direction in many districts of India, that a solution of a most important problem, namely, the enriching of the soil, would be found. He would like to allude to the export of cotton seed from India at the present time. The author had pointed out that 220,000 tons left India for this country last year. That seemed to him (the speaker) rather unfortunate. Any quantity of cotton fibre might be sent out of the country without affecting the fertility of the soil, but in exporting cotton seed, there was being sent away from the soil some of its most important and valuable constituents. He was not one of those who thought that the remedy for the evil was the prohibition of the export of India cotton seed. He rather looked for the solution in quite a different direction, namely, to the establishment in India of mills for the extraction of oil and the manufacture of cotton-seed cake. He ventured even to be so bold as to commend that suggestion to the favourable notice of English capitalists. He believed that there was a considerable fortune to be made in extracting oil in India, partly because the cotton-seed oil was of value in all European countries as well as in India itself, and also because the residue left after the extraction of the oil, not only was satisfactory as manure, especially for cotton, but was also a very valuable feeding-stuff for animals.

The CHAIRMAN proposed a vote of thanks to the author for his valuable paper.

Sir M. M. BHOWNAGGREE, K.C.I.E., in seconding the resolution, expressed the thanks of the Indian Committee to Sir James Monteath for presiding. His observations on the paper proved that an expert chairman had been found for an expert lecture. Sir James Monteath had devoted long years of valuable service to India, and as he did not appear very much in public, he (the speaker) might take that opportunity to recall, with a special sense of gratitude, the arduous labour that Sir James had bestowed in grappling with famines to find out remedies and to alleviate the distress which prevailed at those times. Sir Mancherjee further said that before the meeting dispersed he would like to refer to one remark which fell, he thought unintentionally, from Professor Voelcker. The Professor said that the natives of India would so far as he could see never be fit to occupy any very important or prominent position in the Agricultural

Department. He (the speaker) was perfectly sure that the Professor did not mean to say that in the sense in which it might be received in India. He thought it was generally agreed that in intelligence, diligence and capacity, for study Indians were as good as any other men of any other country. As far as intelligence and work were concerned he contended that the native of India could well hold his own in any department of public service, and he appealed to Professor Voelcker either to withdraw or modify his statement.

The motion was carried unanimously.

Dr. Voelcker, in reference to the remarks made by Sir M. M. Bhownaggree, desires to explain that Sir Mancherjee must have misunderstood what he (Dr. Voelcker) said, as intending in any way to reflect upon either the intelligence or the industry of the native Indian. For these he has the highest regard. His remarks were intended to apply solely to the "capacity for original research," which is an altogether different matter, and on this point he must be allowed to hold his opinion as expressed.

Mr. Lawrence writes :—Owing to the lateness of the hour I was compelled to reserve my reply on the discussion ; and even now, with leisure before me, I feel I must resist the temptation offered me by Lord Reay to indulge in a dissertation on such topics as agricultural indebtedness and the field for co-operation. Attempts have been made in all provinces to protect the peasant from extortionate landlords and moneylenders; these attempts have aroused the opposition of the latter classes, and it is doubtful whether they have penetrated the intelligence or gained the gratitude of the peasants. The Deccan Agriculturists' Relief Act, to which Lord Reay especially referred, has after twenty years' experience received anew the stamp of official approval, and has been extended in its main provisions to Sind and several fresh areas in the Bombay Presidency. The Veterinary and Remounts Departments are still directly responsible for the provision and care of bulls and stallions in most areas ; in some the co-operative system of maintenance by village communities is being developed. The cultivation of sugar-cane in the immediate vicinity of the Poona cantonments has been forbidden for many years, and no difficulties have arisen recently between the cultivators and the sanitary authorities. Mr. McMinn told us of the astonishment felt by merchants in Calcutta at the report that the Agricultural Department had grown 1,000 lbs. of cotton to the acre in Sind, and of the suggestion that this feat was more remarkable than the cultivation of the Egyptian staple. It is true that Calcutta has little experience of cotton, but had these gentlemen consulted the Sind agricultural statistics of the last ten years, they would have found that the indigenous plant had constantly returned this yield on the virgin lands of the new canals. Mr. McMinn further pointed out that certain canals were constructed by the Mogul emperors for their private benefit, and not for irrigation. This is undoubtedly the case, but the fact remains that not only in the Western Punjab and in Sind but also in the Bombay Deccan the Mohammedans introduced elaborate systems of canal irrigation ; whether before or after the Mogul period is immaterial. To the Chairman, Sir T. Holderness, Sir G. Watt, Professor Voelcker, and Professor Wyndham Dunstan, I have only to offer my acknowledgments. Sir G. Watt's monumental work, "The Cottons of the World," supplied me with much valuable information, and Professor Voelcker's "Improvement of Indian Agriculture" is still the *vade mecum* of the earnest enquirer.

Mr. W. Parsons writes :—Had it not been for the lateness of the hour, and the number of speakers who took part in the extremely interesting and instructive debate which followed on Mr. Lawrence's able paper, I should like to have borne my humble testimony in confirmation of what fell from Mr. Lawrence as to the value of scientific effort in connection with the tea industry in India. As secretary of the Bengal Chamber of Commerce, and of the Indian Tea Association for the last ten years, I have naturally had a good deal to do with the organisation of the scientific department of the latter body, to which Mr. Lawrence referred in terms of appreciation. The scheme, which mainly owed its inception to Sir James Buckingham, when chairman of the Assam Branch of the Indian Tea Association, was materially assisted in its earlier stages by Sir George Watt, whose book, "The Pests and Blights of the Tea Plant," had drawn attention to the importance of the matter, and who when superintendent of the Indian Museum, was good enough to allow us, with the sanction of the Government of India, to establish our first laboratory there. The great success which has attended the scheme is due without doubt to the vigour, energy, and scientific ability with which its operations were conducted by Dr. H. H. Mann, whose services we were fortunate in securing at the outset. That he was the right man for the post events have abundantly proved, and there was universal regret throughout the tea industry when he was appointed by the Government of Bombay to be the first Principal of the new Agricultural College at Poona, from which so much is expected, coupled with satisfaction at the official recognition of his worth. Personally I should not have thought that so large a percentage as 25 per cent. in the increased production of tea could be credited to scientific effort. I do not, however, in any way desire to challenge Mr. Lawrence's statement which he has no doubt good authority for making, but I would like to say in addition, and in this I think I shall be borne out by tea planters generally, that where scientific assistance has been of most value is in the improvement of the manufacture and, consequently, of the quality of tea.

EIGHTH ORDINARY MEETING.

Wednesday, January 29th, 1908; SIR WILLIAM HENRY PREECE, K.C.B., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Chowdhury, Manmatha Nath Ray, 18, Rawdon-street, Calcutta, and Santosh District Mymensingh, India.
Matthews, Ernest Romney, F.R.S.E., A.M.Inst.C.E., F.G.S., Bridlington, Yorks.
Maung Maung, 40, Phongyi-street, Rangoon, Burma.
Notley, Charles K., Honolulu, Territory of Hawaii.
Shepherd, James Whaley, A.M.I.Mech.E., care of The Carnatic Mills Co., Ltd., Madras, India.

The following candidates were balloted for and duly elected members of the Society:—

Ashby, John Thomas, Edenholme, Hatherley-road, Kew-gardens, Surrey.
Bunau-Varilla, Phillipe, 53, Avenue d'Jena, Paris, France.
Chatterjee, Pasupati Nath, The Palace, Burdwan, Bengal, India.
Cope, Mrs. Therese Elizabeth, 10, Connaught-mansions, Battersea-park, S.W.
Cox, Fred. J., M.I.Mech.E., 104, Park-street, Gloucester-gate, N.W.
Davidson, T. Gerard, 44, Great Russell-street, W.C.
Durham, Miss M. Edith, 116, King Henry's-road, South Hampstead, N.W.
Gilder, Ardeshir Nowroji, Parvati-building, Thakordwar, Bombay, India.
Gray, St. George, B.A., M.B., Senior Medical Officer, Calabar, Southern Nigeria, West Africa.
Griffiths, John Norton, 62, London-wall, E.C.
Jack, John W., 37, Queensferry-street, Edinburgh.
Krishnamacharya, M., M.A., B.L., Triplicane, Madras, India.
Lukis, Wilfrid Ravenshaw Fellowes, M.I.Mech.E., Rising Sun Petroleum Company, Limited, Nonai Installation, Aomori-Keu, Japan.
McClure, David Simpson, Bank of Bengal, Calcutta, India.
Maung, Maung, 7, Victoria-street, Bassein, Burma.
Midgley, Albert Henry, 86, Cranmer-road, Forest-gate, E.
Nicholson, Dr. Jonathan, Llanberis, Sandford-road, Bromley, Kent.
Pearson, Hugh, Rockend-terrace, Milngavie, Scotland.
Rodger, Robert, F.C.S., 54, Rostrevor-road, Fulham, S.W.
Sanderson, James, New Plymouth, New Zealand.
Spencer, Major Maurice, 67, Vanbrugh-park, Blackheath, S.E.
Taylor, William Henry, A.M.I.E.E,, 15, Hampton-road, Forest-gate, E.
Turnbull, Herbert, M.I.E.E., 2, Myddleton-park, Whetstone, N.
Watts, George William, 63, Breakspears-road, Brockley, S.E.
Wicks, Joseph Thomas, 185, Fore-street, Edmonton, N.
Wright, Thomas D., Northampton Institute, St. John-street, Clerkenwell, E.C.

The paper read was:—

THE REFORM OF THE PATENT LAW.

By JOHN WILLIAM GORDON.

When I had the honour in November, 1906, of assisting at the discussion in this room of the subject of Patent-law reform, it was understood that the Government were contemplating the introduction of a comprehensive measure and prepared to consider suggestions for the improvement of the law. In these circumstances the discussion which took place was marked in a very special degree by the feature of reality, and, as the Society secured the participation in that discussion of many of those gentlemen who were known to take an interest in the subject, the expression of public opinion on that occasion was particularly effective. In reverting to the subject now when the measure, then under discussion, has not only taken shape but has passed the Legislature and gone into effect as law of the land, I propose to bring it under your notice with special relation to the views which found expression in that discussion and, so to speak, to report progress to the Society in connection with the legislation which has taken place.

But before going to the substance of the measure, it may be of interest if I place on record the course, somewhat unusual, which was adopted in passing the measure through Parliament. When the matter was before the country, and this Society, in 1906, it was known that the Government proposed to bring in an Amendment Act, but it had not at that time transpired that they proposed to go farther than that. Shortly afterwards, however, it was announced that two measures would be introduced, one to amend, the other to consolidate, the law. This involved the curious result that the Amending Act should be passed and repealed in the same Session. In fact, it was so passed and repealed, almost in the same breath, for the two Acts follow one another

in the Statute-book, are consecutive in point of number, and received the Royal assent at the same Parliamentary function. Thus the Amending Act, although passed with all due solemnities, never had the force of law. This procedure, although not altogether without precedent, is very uncommon, having happened, I believe, no more than three times in the course of the last thirty years. Indeed, in the other two cases the repealed Statute remained for a few weeks upon the Statute-book, and was not, as in the present case, actually still-born. The practice of repealing and replacing an elaborate Act of Parliament in such hot haste is one which does not commend itself on theoretical grounds, and the present experiment is hardly likely to raise it above the theoretical level in public estimation. The natural consequence of such precipitation has in fact led to some serious errors in the drafting of the Consolidating Act. These, however, are matters at which it is not necessary to do more than merely glance this evening, and therefore I propose in the present paper to confine my attention to the Amending Act, or, to speak more accurately, to those clauses of the Consolidating Act, which are taken from the Amending Act of 1907.

There having been no formal resolution and no adopted recommendations, it is perhaps not altogether easy to ascertain from the discussion which took place here in November, 1906, what were the views prevailing at the meetings of the Society upon the various points discussed. But on certain points there will be little doubt, and foremost amongst these is the view that the time had come when it was necessary to put some stop to the unregulated claim of monopoly rights by patentees, whose interest it is, not to introduce patented inventions, but to prevent their introduction among the industries of this realm. This part of the case for reform had already been worked out with considerable thoroughness; notably in connection with its dicussion by the Manchester Chamber of Commerce; and Mr. Levenstein, who put the views of the Chamber before this Society on that occasion, not only identified the mischief, but also suggested the lines of the remedy which his Chamber had urged upon the Government. Comparing that proposal with the Bill, I observe that Parliament has adopted the Manchester proposal without serious modification. Section 27 of the Act provides that—

"At any time not less than four years after the date of a patent and not less than one year after the passing of this Act, any person may apply to the Comptroller for the revocation of the patent on the ground that the patented article or process is manufactured or carried on exclusively or mainly outside the United Kingdom.

"The Comptroller shall consider the application and, if after inquiry he is satisfied that the allegations contained therein are correct, then, subjcct to the provisions of this Section, and unless the patentee proves that the patented article or process is manufactured or carried on to an adequate extent in the United Kingdom, or gives satisfactory reasons why the article or process is not so manufactured or carried on, the Comptroller may make an order revoking the patent either—(*a*) forthwith; or (*b*) after such reasonable interval as may be specified in the order, unless in the meantime it is shown to his satisfaction that the patented article or process is manufactured or carried on within the United Kingdom to an adequate extent: Provided that no such order shall be made which is at variance with any treaty, convention, arrangement, or engagement with any foreign country or British possession."

Now, if this be compared with the proposals submitted to the Board of Trade by the deputation for which Mr. Levenstein spoke, it will be seen that the Manchester proposal has been adopted in its entirety. Mr. Levenstein, as reported on page 39 of the *Journal* of this Society for the 30th November, 1906, said:—

"The deputation . . . . asked the President of the Board of Trade to re-instate the law as laid down in the Statute of Monopolies, with several provisos. It did not ask that every patentee must work his patent, but that a patentee should only be called upon to work his patent in this country if he worked it abroad. A second proviso was that he need not be called upon to work it in this country if he justified his inaction to the satisfaction of the Board of Trade."

It is not only of interest in this place, it is also a valuable aid to the construction of the Act, thus to compare its language with the suggestion out of which the clause grew, and which it manifestly is intended to embody in the form of law. The language of the clause, taken by itself, is ambiguous and might very well give rise to considerable difficulty and even, possibly, to some unexpected results if it were not possible to obtain assistance in interpreting it from extraneous sources. Thus, the condition that a patented article or process be manufactured and carried on mainly outside the United Kingdom, suggests three totally different states of fact. It may mean that, although the patented manufacture is carried

on in its entirety within the United Kingdom, it is also carried on elsewhere, and that the scale on which it is carried on outside the United Kingdom is larger than the scale on which it is carried on within the realm. There is, however, a second sense in which the words of the Statute might be understood. It might clearly be said that the manufacture of bicycles was carried on mainly abroad if the wheels, the tyres, the frame, and the gearing were all produced abroad, imported as separate parts, and simply put together in this country. In that case there would be no importation of a bicycle, the importation would be restricted to bicycle parts. But that bicycle, although in one sense not manufactured abroad, might in another sense be said to have been mainly manufactured abroad, and sooner or later the question is pretty sure to arise as to whether a manufacture carried on in this way by producing the parts in other countries and assembling them here into their final form is not within the mischief aimed at by this clause.

The third sense in which the question may arise may be illustrated by the well-known case of the patent originally granted for the telephone and phonograph. In these days the two instruments would probably be held to be different inventions, but when both were new the telephone, naturally enough, was regarded as a phonograph worked by electricity, and the phonograph as a mechanical telephone. Both instruments were comprised in one patent grant, but they gave rise to totally distinct manufactures. Would the fact that the one instrument might be mainly manufactured within the realm in such a case be held sufficient compliance with the Act, even although the other—the really important manufacture, suppose—was carried on exclusively abroad? If not, must the rule be applied distributively to all the separate claims made under a patent, and the patentee called on to show that his invention, in every separate application of it, is carried on mainly within the realm?

It is very difficult to see, if the language of the Act alone be considered, how this question should be decided. But when we know that the demand for legislation in obedience to which this Act was passed was a demand that every patentee should be required, subject to certain allowances, to perform the duty of introducing his patented improvement into the manufactures of this country, it becomes easy to decide between the two views. The real question, then, is not whether the major part of the work connected with the carrying out of a patented improvement has been done here or there, but whether the improvement itself in its entirety has or has not been fairly introduced into this country. If a patentee who by manufacture elsewhere has demonstrated his ability to bring his invention into use, shirks his responsibility so far as this country is concerned, that will be a good ground of revocation.

While thus the principle may be identified with some confidence, it must be admitted that the Act will probably be a very difficult one to work. The criterion indicated—that of the preponderance of the manufacture carried on abroad—is one which affords but a very imperfect test of the matter which is essentially in question. There are very many manufactures, and with the spread of industrial enterprise over the whole world their number is daily increasing, in which it is impossible for this country to have a main share of the industry. Let me take by way of illustration the printing trade. That is one which is carried on by very elaborate mechanical appliances to the perfection of which a great deal of inventive industry has been recently applied and is being applied at the present time. Take the case of some valuable invention in connection with type setting or printing machinery. There is, of course, an enormous market for such an invention in this country, there is a market still larger in America; there is, it may be, a market larger yet on the Continent of Europe. Now, if the supposed invention is of sufficient importance and sufficient merit to make its way in all these different countries it is not to be supposed that it could be mainly carried on within the United Kingdom. No patentee could be expected to bring about such a result as that.

The illustration just given is typical of an immense number of inventions, probably of the great majority of patented inventions, and if the Act contained no further provision than that of Sub-section 1 for meeting such a case it would be clearly impracticable. But Subsection 2 entrusts to the Comptroller a very large measure, in fact an enormous measure, of discretion. In the first place, it would appear that he is entitled altogether to disregard the fact that the invention is carried on mainly outside the United Kingdom, and to put the question to himself in a different form. For Sub-section 2 says, the Comptroller may

be satisfied if the patentee proves that the manufacture is carried on to an adequate extent in the United Kingdom. In the case just proposed it is hardly conceivable that the Comptroller would think the extent inadequate if the fair demands of the printing trade within the United Kingdom were adequately met. The fact that the very much more extensive printing trade outside the United Kingdom made a larger demand, which was met on a proportionately increased scale, could hardly weigh with him. It may, therefore, perhaps, be taken for granted that the effective measure of a patentee's responsibility under the clause is not expressed by the word "mainly" in Sub-section 1, but by the words "inadequate extent" in Sub-section 2.

There is another case of difficulty which may be proposed, and to which your attention was called upon the last occasion. It was then pointed out that there are a great many manufactures which cannot advantageously be carried on within the realm at all, although it is of great importance to us that they should be carried on elsewhere. Such processes, for instance, are most metallurgical processes which are concerned with the production of such products as gold, mercury, platinum, and various other metals which might be named that do not occur to any material extent among the mineral deposits of the United Kingdom. All these things have to be brought to us from abroad, and their production may be indirectly, though it cannot be directly, promoted by the grant of British patents. A particularly striking illustration of this case is one which was mentioned in the course of our last discussion, an invention by which nitrate fertiliser is electrically produced from the nitrogen of the atmosphere by the aid of water-power. Such an industry, carried on where water is abundant, may very possibly become in the not distant future one of the mainstays of our agriculture. The manufacture is, in fact, protected by British patent rights, and its result would probably be of more importance to this country than to any other country in the world. This is a striking case in which it would be suicidal to insist that the manufacture should be mainly carried on within the realm, for the expense of producing nitrate by steam power, would make the scheme commercially impracticable. To provide for such a case as this, the second sub-section contains a further reservation. The patentee may not only prove that his manufacture is carried on to an adequate extent within the United Kingdom, he may also, if he can, produce satisfactory reasons to explain why it is not so carried on at all. The case to which I have just called your attention is probably one of those in which the authorities would consider that satisfactory reasons could be given.

It will now appear that although Parliament has adopted the Manchester proposal, it has not felt equal to the task of expressing that proposal in words. It is clear that the effective law upon this subject remains to be made. It will be embodied in those rules which the Comptroller-General, or the Judge to whom an appeal from the Comptroller's decision is allowed, may adopt for his own guidance. Probably these rules of practice, necessarily very difficult to frame, will be better elaborated in that way than by the deliberations of a Committee of the Legislature, which would regard the matter from a purely theoretical point of view. But it can hardly be contemplated as a satisfactory settlement of the law, that matters of so great importance should be left to be finally settled by the discretion of an executive officer. It will be a matter of great importance that those whom it concerns should keep under close observation the dealings of the responsible authorities with this matter, and, sooner or later, when sufficient experience has been gained, should bring the whole question afresh to the notice of Parliament, in order that the tentative rules which may be expected to arise in the course of practice, may receive systematic form and parliamentary sanction.

Another point which engaged the serious attention of the Society was the question of the tribunal by which the power of granting compulsory licenses was to be exercised. In connection with this part of the subject, reference may be made to the speech of Sir Lloyd Wise, who voiced the very generally entertained objection to the Privy Council that its procedure was too expensive for the purpose in question. By a very curious course of negotiation, the Privy Council had been originally fixed upon as the tribunal to administer this part of the law with the express object of minimising the expense of securing compulsory licenses. The compulsory licensing system had been theoretically in existence in this country since the year 1883, but it is well known that it was not till many years after that date that the clauses of the 1883 Act providing for the grant of compulsory licenses were put into operation. Under the original Act the authority charged with

administering the system was the Board of Trade, and when the law came to be a practical reality, it was, in fact, administered by referees, who acted as arbitrators under the authority of the Board. That method was said to be expensive, whether or not with sufficient reason I do not know. At any rate, in the year 1902 an Act was passed to facilitate the obtaining of these licenses, and the jurisdiction was transferred from the Board of Trade to the Judicial Committee of the Privy Council. Perhaps it would be more accurate to say that the jurisdiction was transferred from the Board of Trade Referees to the Judicial Committee of the Privy Council, for under that Act a petition was still to be presented to the Board of Trade and came before the Privy Council upon a ree rence from the Board. It will be seen that this altered procedure did not in fact promise much relief in the way of expense. There is no reason why litigation carried on before the Privy Council should be less expensive than before the less distingushed tribunal selected by the Board of Trade. It was probable that if the matter had been duly considered from this point of view it would have been seen, even by the promoters of the original Bill, that this proposal afforded no prospect of relief upon the score of expense. What happened, in fact, was that a departmental committee having been appointed by the Board of Trade to consider the matter, had reported in favour of transferring the jurisdiction from the Board of Trade to the High Court. The Bill, as originally drafted, was drawn upon those lines. In the course of its discussion somebody seems to have suggested that an application to the High Court involved the possibility of recurrence to the Court of Appeal, and in the last event to the House of Lords, and it was said that the costs of such an appeal would be more formidable than the costs we wanted to escape —of an arbitration before a referee appointed by the Board of Trade. Hence arose the curious suggestion that the petition should be sent for hearing in the first instance to an appellate tribunal, and the Judicial Committee was selected, apparently for no other reason than this—that from the decision of the Judicial Committee there could be no appeal. The result of this experiment in the five years since 1902 has been exactly what experienced people at the time said it would be, that is to say, the amended procedure made an end of the process, and there is in fact no report of any case of an application for a compulsory license during those five years which advanced to the stage of a hearing before the Judicial Committee.

The new Act has at length supplied the obvious remedy. The only thing which can minimise the expense of litigation is the security of efficient tribunals, and the efficiency of a tribunal depends in even larger measure upon the conditions under which it adjudicates than upon the competency of its Judges. Now, the only tribunal which is favourably circumstanced for deciding upon the question of granting a compulsory license is the High Court. The reason of this may be stated in a very few words. The question of a compulsory license invariably arises in connection with the question of the infringement of some specific patent. Now, as a rule, the manufacturer or dealer, as the case may be, proceeds about his ordinary business in happy ignorance of the patent rights of other people. For the most part the labour and expense of searches relating to patent rights would be too great to be undertaken by practical men. In certain lines along which invention is actively proceeding, and a large number of people are working in the same direction, it is possible for one manufacturer, especially if he be in a large way of business, to keep his eye upon what his competitors are doing, and to have a very comprehensive knowledge of the state of the patent register. In such a case as that the manufacturer may know perfectly whether it is or is not necessary for him to apply for licenses to carry out the manufacture upon which he is engaged and upon which he proposes to embark. But, at best, a case of that sort is exceptional, and manufacturers in that position do not, in fact, very often figure as defendants to patent actions in our courts of law. They are, speaking generally, tough customers to tackle, and where a patent right is clear, they are usually in a position to make what terms it is necessary for them to make with the patentee, by voluntary arrangement.

But the case is very different with the small manufacturer. He cannot afford to spend the time necessary to make himself personally acquainted with the Patent Office file, nor can he afford the expense of keeping an expert staff at work upon the file for his information. He must, therefore, take his chance in patent cases, and he does. Every now and again it happens that he gets a threat of proceedings, and is warned to desist from some manufacture in which he is actually

engaged. It is then that the question of compulsory license arises in an acute form. It may very well happen that the manufacture which is the object of attack, is the result entirely of his own industry and invention. The effect which our law gives to patent rights, enables a patentee, in many cases, to exercise control over not only the industry which he may himself have created, but also, by means of what is known as a master patent, to enjoy rights in the tributary inventions and manufactures of other people. In the aggregate these tributary inventions, sometimes improvements upon a patented invention, sometimes themselves wholly independent inventions, form a very important branch of our manufacturing industry. Their claim to the protection of the law has been recognised ever since the passing of the compulsory licenses clauses in the Act of 1883, and by the provisions of the Act of 1902 they were placed theoretically on an entirely satisfactory basis, for it was therein provided that a compulsory license might be ordered to secure the reasonable requirements of the public if any existing industry, or the establishment of any new industry were unfairly prejudiced, as well as in the case in which the public demand for a patented article was not reasonably met by the patentee.

Following out the line of thought suggested by this provision of the Act, it will easily be seen that the question of unfairly prejudicing any industry or preventing the establishment of a new industry within the realm is a question which must frequently arise in connection with patent actions. It does not invariably so arise by any means. In a great many cases patent actions are brought against people who are concerned as speculators only in tentative efforts to share with the patentee in the benefits of the industry which he has himself established, and whose action, therefore, while it cannot be described as the carrying on of an existing industry, is far indeed from tending to promote the establishment of any new industry, which, on the other hand, it tends to embarrass. But when all allowance is made for such cases, there remains a very considerable proportion of patent actions in which the owner of a master patent seeks to circumscribe the activities of those whose industry is entirely independent of himself or of his inventions In such a case the Legislature has clearly recognised that the rights, not only of the alleged infringer, but also of the great public are involved. It was, however, quite unreasonable to suppose that when a patent action of this sort was started against some small infringer, he would have either the courage or resource to enlarge the area of conflict by instituting proceedings on his own account before the Judicial Committee of the Privy Council. Herein lay the secret of the failure of the Act of 1902.

Tested by this criterion the new Act may be said to contain a promise of a large and most beneficial reform. At last the mischief of circuitous proceedings is remedied, and the jurisdiction to deal with an application for a compulsory license is conferred upon the High Court. It may thus be dealt with simultaneously with the question of infringement in one proceeding, and not only is it thus made available when it is wanted, but inasmuch as the applicant for a compulsory license is in any case, if he intends to defend the infringement action, compelled to come into Court, the expense to the parties of the additional litigation involved in trying the application for a compulsory license under these conditions is minimised.

It is not to be expected that the chief effect of such a provision as this relating to compulsory licenses will be made manifest by actual litigation. The knowledge that such a remedy exists will incline both patentees and manufacturers to agree with one another, and to do by voluntary arrangement what they can be compelled to do by process of law. It is in this indirect way that these remedial provisions of the Act, designed to secure the interest of the patentee in introducing his patented manufacture within the realm, do in fact take their chief effect. But, of course, to render them effective in this way they must be thoroughly available remedies. Machinery so elaborate as that of the Act of 1902 defeated its own object. The predacious patentee knew perfectly well that the chance was inconsiderably small of its being brought into operation against him. Now, however, when he cannot himself assert his rights against a defendant without exposing himself to an effective rejoinder along these lines, it may be confidently expected that he will moderate his tone and learn to find his own interests compatible with those of the industrial British public.

There was a third subject which, although it did not receive so much attention in the discussion, was brought very definitely under the notice of the Society in 1906. The subject to which I refer is the imposition of oppressive conditions as terms of licenses granted under

patents, and an illustration which was then used has been very prominent in the course of those discussions in and out of Parliament which accompanied the passing of the New Act. The mischief was identified when we were discussing it on the last occasion as that of the "tied house" system, a scheme of licensing by which a patentee makes use of his patent right to secure, little by little, a controlling interest in the tools and manufacturing plant of some particular trade, and so to become, in respect of the industry which he honours with his attention, what may perhaps by analogy be called a "plantlord." A very resolute and to a certain extent a very successful attempt to create a plantlord system in connection with the boot trade has been made in recent years. Although the operations of the projectors were carried out with very considerable skill, they were, in fact, a little too crude and they gave rise to a public alarm, which has terminated in what are by far the most stringent provisions of the present Act. Section 38 is devoted to this subject and opens with these words:—

"It shall not be lawful in any contract made after the passing of this Act in relation to the sale or lease of, or license to use or work, any article or process protected by a patent to insert a condition the effect of which will be:—(*a*) To prohibit or restrict the purchaser, lessee, or licensee from using any article or class of articles, whether patented or not, or any patented process, supplied or owned by any person other than the seller, lessor, or licensor, or his nominees; or (*b*) to require the purchaser, lessee, or licensee to acquire from the seller, lessor, or licensor, or his nominees, any article or class of articles not protected by the patent; and any such condition shall be null and void, as being in restraint of trade and contrary to public policy."

A number of provisions follow this introductory clause, some intended to limit its application and prevent it from interfering with legitimate contracts, others intended to facilitate the operation of the rule, and make successful opposition to a plantlord easy to those over whom he endeavours to establish his monopoly. Furthermore, one clause of particular stringency makes the existence of a plantlord contract a ground of defence to an action for infringement, while another clause—Sub-section 5 (*b*) of Section 24—makes the existence of such a contract a ground for the grant of a compulsory license. Of these provisions in the Act it is not possible to speak without admitting that a considerable amount of doubt must suggest itself as to the exact nature of the effect which they will produce. There is always a great risk in enactments of this kind, which seriously modify existing contractual relations, of results which at first are unforeseen, and probably there is no one so self-confident as to feel satisfied that he could tell beforehand how a clause like this will in fact take effect. But there can hardly be a doubt that it will suffice to nip the mischief in the bud. In these clauses the Act has been drafted with very special care, and sets out with great fullness and exactitude the precise intentions of the Legislature. Questions will, of course, arise as to the application of the rules laid down, but there can hardly be any question as to their scope and drift. Again, the limitations which have been placed upon the rules have themselves been very carefully and fully elaborated, and I may confess for my own part some difficulty in knowing which more to admire, the boldness with which the mischief has been attacked on the one hand, or, on the other hand, the care and, so far as I am myself able to form an opinion, the skill with which these limits have been laid down. This subject is, without a doubt, the most difficult of all the subjects with which the new Act deals, and I should be very presumptuous were I to venture to use the language of peremptory criticism, whether favourable or adverse, concerning these provisions of the Act. With the object in view everybody will sympathise, for indeed there could be no more terrible calamity than the creation of such a system of control as is here in contemplation. At the same time an operation, even though skilfully performed upon so delicate an organism as the contractual relations of tradesmen and manufacturers with one another, must always be attended with risks, and perhaps the most it is possible to say at the moment about this provision is that it has been very carefully elaborated, with the object of preventing a very formidable mischief, and that both its practical importance and its theoretical interest will make the working of the system an object, for many years to come, of lively interest to all who are concerned in the working of our Patent-law.

The foregoing provisions of the Act may be described as the amendments introduced in response to popular demand. In addition to these, a large number of amendments have been introduced on the initiative of the Patent Office itself, and as the result of experience and observation accumulated now over many years. These, for the most part, are matters

of detail, and do not call for particular notice in the present connection. They are designed to facilitate the course of proceedings and, with the possible exception of the clauses which confer upon the Comptroller-General the power to award costs, they can hardly be said to touch any question of principle.

The power to award costs, now for the first time conferred upon the Comptroller, does indeed mark a new departure from the settled policy of former Statutes. In judicial proceedings, where one party claims a right which the other party denies, the power to award costs is entrusted to the Courts by way of penalising the wayward conduct of the party in default; whether his default consists in advancing an unfounded claim, or in resisting one which is well grounded in law and justice. No similar considerations apply in the case of Patent Office procedure. Opposition to the grant of a patent or amendment of a specification is based not usually on grounds of right but on grounds of technical propriety. The patentee, for instance, who opposes a subsequent grant on the ground of a grant previously made to himself does not by the result of his opposition, even if successful, in any way increase his own rights. It is well settled law that what he acquires by his own grant can neither be increased nor diminished by any subsequent grant from the Crown to another person. The result of his opposition, therefore, is to leave his own rights as against the later applicant unaffected. On the other hand his action in a proper case does enable the Patent Office to exercise its powers with better discrimination than would be possible without such assistance. It is a public duty which the opponent fulfils although he is usually animated in the performance of that duty by the expectation of securing some private advantage in the result. Now, it may indeed be said that it is quite right that a man performing a public duty should be secured against expense in doing so. But it is not equally easy to make out the proposition that the indemnity to him should be paid not out of public moneys but out of the private purse of the applicant for a patent. It is, of course, obvious that if the applicant is seeking some advantage to which he is not entitled it would be reasonably fair that the necessary expense of restricting his claims to what is properly allowable should be charged to himself. The grant is made for his advantage, and the necessary expense of making it may quite reasonably be made to fall on him. That, however, is a consideration that does not very strictly apply to the question of giving litigious costs against him. In fact he pays a sealing fee which is sufficient, on a average, to defray the expense of all the proceedings considered necessary at the Patent Office to secure the proper limitation of a patentee's claims. It is in these circumstances a little hard that in a case which happens to be one of difficulty the applicant for a patent should be put to additional expense, an expense calculated not on the basis of the advantage to the patentee or to the public resulting from the inquiry, but upon the basis of party and party costs. This matter might seem to be unimportant or important only within such a degree that it might fairly be left to settle itself as the result of experience and in the course of time. But what one knows perfectly well is that the system of preliminary inquiry into the subject-matter and form of claims in foreign Patent-offices, such as those of the United States and of Germany, has become very formidably expensive; and in some of our colonies, where American and German models have been followed, the same result has ensued, and the expense of obtaining a patent in the case of opposition is quite comparable to the expense of a patent action. This is a very real and substantial hardship, because the result of an inquiry at a Patent-office never is, and never can be, final in favour of the patentee. The nature of patent rights is such that in all countries it has been found necessary to make the validity of the grant dependent upon well ascertained principles of law, and subject to the jurisdiction of the Courts of Law. Hence arises a case of special hardship. The expenses of the preliminary inquiries cannot be avoided, since the patenttee has no such choice, as in a case of infringement, of sitting still and letting things take their course. The applicant therefore, has good ground of complaint if in these circumstances he is put to heavy expense which cannot in any case afford him any advantage in the eye of the law. Foreseeing these difficulties, our Legislature in 1852 and 1883 provided, wisely as I venture to think, that these preliminary proceedings at the Patent Office should be conducted at the parties' cost. The result has been so admirable that like many other good things it has passed unobserved. In fact, the necessary cost hitherto of obtaining a British patent, and so giving a new invention a fair start, has been

greatly less than that of obtaining a disputed patent in any other considerable country in the world. I limit this statement to the more considerable countries, because I cannot pretend to have a sufficient knowledge of the procedure at the Patent-offices of some of the smaller countries and colonies to make a universal statement.

Whether this very desirable state of things will or will not continue under the new regime it is of course impossible to foresee. Everything will depend upon the judgment with which the new power is administered. The law officers, who have for some years past possessed the power of awarding costs have established a very sound rule for their own guidance, with the result that appeal proceedings are conducted before them at a very moderate cost. If the Comptroller-General follows their lead he will probably be able to maintain the high character of the British Patent Office in respect of the reasonableness and inexpensive character of the demands which it makes upon applicants.

There is one provision in the Act of which it is necessary to take notice, but as to which I am quite unable to indicate the source from which it comes. The 19th Section of the Act provides for the granting of a kind of subsidiary patent to be called a "patent of addition." Patents of addition are to be found in many other systems of Patent-law, but it is difficult to understand what purpose they are intended to serve in our own system. The history of patents of addition is a somewhat interesting story. They originated in Napoleon's legislation in the year 1810, and the circumstances, so far as it is now possible to ascertain them, were as follows. Prior to the revolution, French industry had been fettered by privileges of all kinds, but had not enjoyed the benefit of any system of patents for inventions such as had grown up in our own country under the Statute of Monopolies. In other words, all through the eighteenth century France suffered from the mischiefs of monopoly and simultaneously from the want of any well considered Patent-law. The National Assembly put an end to both those anomalies. By a famous decree it abolished all monopolies, and at the same time it passed a law modelled upon the English practice creating patent rights for inventions. Now there was at that time a doctrine prevalent in English law that any invention which merited a patent grant must be a matter of very sensible public importance and merit. The doctrine was forcibly expressed by Sir Edward Coke, who said that to be patentable the subject-matter of a grant must be matter of urgent necessity and evident utility: and, referring to an old patent granted for some particular method of melting lead he said that it had rightly been described as a trivial matter like putting a new button upon an old coat, and that it was for that reason held unpatentable according to the rules of common law. This doctrine prevailed in this country until well into the last century, and when the French legislators were looking out for a model upon which to shape their own law, they found that the experienced English lawyers took this view. They found also that the English lawyers had arrived at this view of the matter by a course of argument which did not, by any means, commend itself to the Republican way of thinking. The original idea of patent grants in this country was that they were made from the bounty of the Crown, and it was considered unbecoming that the King should concern himself to make a special grant of privilege unless it were in respect of some matter of urgent necessity and manifest utility to the realm. Now, from this view of the matter, the French Legislature entirely broke away. They were not only abolishing privilege, they were also abolishing royalty, and the idea that any legal right could arise from the exercise of royal bounty was, of course, to them inconceivable. They sought and found another basis for the theory of patent right, and they found it in a legal fiction which, in our own days, had come to be very widely accepted. They looked upon the patent as a contract between the inventor and the State. Social contact was, indeed, the tap root of most of their political theory, and nothing was more natural than they should apply this doctrine, among other things, to the theory of the Patent-law. In their view, therefore, the patent became such a contract, between the public on the one hand, and the inventor on the other. The inventor's privilege was paid for by the advantage which the public secured in being taught the secret of the invention.

Now, on this view of the matter, Sir Edward Coke's theory of the coat and the button was altogether inappropriate. If an invention related only to a small matter, like the button on the coat, then the patent was a small matter in its turn, and there was no royal

dignity to be offended by being involved in a trivial transaction. It was on these lines, therefore, that the National Assembly legislated in making the validity of a patent turn upon the novelty, and not upon the urgency of its subject-matter. This first experiment was not, however, quite successful. In the course of seven or eight years it turned out, or was so supposed, that a number of people set themselves to prey upon inventors by anticipating the course of invention and taking out patents for improvements upon patented inventions by which they blocked the line of development of the original patentees. To us, in the present day, it does not seem that there could be any great objection to a rivalry of that kind, but it struck the French mind at the beginning of the last century as being an illegitimate form of competition. To meet this case, therefore, Napoleon's Legislature introduced the system of patents of addition. The original patentee had the right, within a limited period, to take out a patent for an improvement upon his original invention. During that time he had a preferential right as against all other inventors. Subsequently the field was thrown open and anybody might obtain a patent for an improvement but, by an extension of the original idea, the patentee still retained a measure of advantage. He could take his subsidiary patent for the improvement, not only in the form of a separate grant, but also in the form of a patent of addition, as it is now called, or *certificat d'addition*, as the French word is. Upon such a *certificat* he paid no renewal fees, and it was for all purposes treated as being a mere branch of the original patent. Such, in broad outline, is to this day the principle of patents of addition as embodied in the French law.

In the year 1877, the existing German Patent-law was passed in which an attempt was made to combine the features to various existing systems when, among other things, the system of patents of addition was borrowed, with modifications, from the French system. The modifications were, however, very considerable. In the course of 150 years the original Patent-law both of this country and of France had undergone considerable change. The change was rather in the spirit in which the law was administered than in the letter of the law itself. But neither in this country nor in France was there any remaining trace of the old common-law rule that an invention to be worthy of a patent must be a matter of urgent necessity. This principle, therefore, never found a place in the German system. For a patent of addition of the original French type there was thus no room in the German scheme, and, although the Germans borrowed the name, and may in a sense be said to have borrowed the idea, they modified that idea so considerably that they may perhaps with more propriety have been said to have substituted a new idea for it. The Zusatz Patent in Germany does not differ as to subject-matter from an original patent. There must be the same degree of novelty, the same degree of urgency, the same degree of utility, and the only advantage which the system affords to the original patentee is that by taking a subsidiary patent in this form he escapes the payment of renewal fees. This, in the case of a German patent, is a matter of very considerable importance. Not only are patent fees in Germany on a higher scale than in this country, but, what is of much greater importance in this connection, renewal fees are payable from the first. The fees payable down to the date of sealing under an English patent frank the grant for four years. The patentee has that period of time within which to turn his patent to account and make it remunerative, and during that time he is called upon to pay no fees in respect of his grant. It is difficult to overstate the importance and, as I venture to think, the wisdom of this provision. If new inventions are to be encouraged by a system of patent grants at all, it is evident that the system must be so devised that a meritorious invention may be made to pay its own way, and, to this end, the English scale of fees is admirably adapted. This view, however, did not commend itself altogether to the German Legislature. There the renewal fees during the first period of four years amount to as much as £14, so that if more than one patent has to be taken for the protection of a given invention, the mere expense of keeping the patent right on foot during the very early period within which a notable invention can hardly be expected to be remunerative is very serious. It was to meet this difficulty that the German Zusatz Patent was devised. Involving no liability to renewal fees, it enables a patentee to complete his invention and secure protection for it in its perfected form without incurring the overwhelming expenditure involved in taking a succession of full patent grants.

Such being the two existing systems of

patents of addition, it is at once evident that neither of them fits into our English system. The original ground has disappeared as the result of slow changes in the theory of our law, the modern doctrine being that any degree of utility, however slight, may be sufficient to support a patent. In fact the idea of urgent necessity and manifest utility has disappeared altogether, and with it has gone the reason for a patent of addition of the original type. Equally superfluous is the patent of addition if we regard it from the German standpoint. In point of fact the remission of fees does not affect the fees payable before sealing, so that the mere cost of obtaining a patent of addition is the same as that of obtaining the mother grant. During the first four years, therefore, there is no reduction in the cost of a patent of addition, and it affords, accordingly, no relief to the early struggles of a patentee. On the other hand, what is remitted is the cost to the patentee of renewal fees in the later years of the patent's existence, and for that remission it seems very difficult to find an adequate reason. It certainly is not desirable in the public interest that patents of mature age when not sufficiently remunerative to their owners to bear the charge of renewal fees should be maintained in existence. And it is difficult, therefore, assuming this relief from later renewals to be the only object aimed at by the introduction of this new system, to understand on whose behalf it has been proposed.

A further reason which makes it difficult to look upon the present enactment as the mere introduction of the German system is that the German precedent has been departed from in what is perhaps its most important particular. It is a logical result of the German view that the patent of addition should be capable, when the principal patent falls, of becoming itself a substantive patent grant. There seems to be no possible reason why a patent for matter which might be the subject of a subsisting grant should not be continued in existence if for any reason not involving what I may call its own validity the mother patent falls. Accordingly under these conditions the Zusatz Patent in Germany becomes liable after the failure of the mother patent to the payment of renewal fees and subsists as a self-sufficient grant. This rule of course does not obtain in France. The *certificat d'addition* is, as I have said, a mere branch of the original patent, an additional claim as it were, and if the stem is cut down the branch withers away. Now this same rule has been adopted in the present Act. It is provided that a patent of addition shall remain in force so long as the patent for the original invention remains in force but no longer. This, therefore, puts it on the same footing as a *certificat d'addition* in France which, as we have seen, has been antiquated by lapse of time and change of law.

In these circumstances I must confess myself greatly perplexed to suggest an explanation of the motive with which patents of addition have been introduced into our system of Patent-law. But, if putting question of motive aside, it be permitted to me to conjecture as to the part which they will play in the future development of our law, I should like to suggest for the consideration of those whom it concerns that there is one very important function to which these grants may be made subservient. Our Patent-law, in most respects singularly reasonable and elastic, is in one respect highly angular and technical. The power of amendment by which a faulty specification may be set right is subject to a highly artificial and very rigorous limitation of scope. A defective specification may, with leave duly sought and obtained, be amended by way of disclaimer, correction and explanation, but not by way of amplification. This, in some circumstances, is a matter of great hardship. For none of us, not even the most resourceful of inventors, can be always and entirely wise. We often understand only partially what we understand best, and when it is a question of explaining and prescribing what we understand just well enough for practical purposes, but no better, there is sure to be a large measure of shortcoming in the exposition.

A particular example will make this clear, in shaping which I will take liberty to draw upon imagination to any convenient extent, although my fiction is actually founded upon fact. An inventor treats a given base with a given acid, for a given time, in a digester, at a given temperature. He obtains a new and useful product which he naturally attributes to the reaction between the acid and the base. He patents his new product and describes his way of producing it quite correctly, but with theoretical inaccuracy, for the effect which he attributes to the interaction of the acid and the base alone is, in fact, due partly to the action of a slight admixture of iron derived from the digester, but undetected by his observation of the process and its results. Accordingly his specification takes no account of the really indispensable iron, but this is, at the time

when his specification is drawn up, a matter of no consequence, for digesters are always made of iron, and so this necessary element is always present when the operation is carried out by the method which he describes. But, unfortunately for our inventor, enamelled digesters are brought into use and rapidly replace the bare iron vessels in vogue at the date of the patent. There is nothing in the specification to tell the operator that in these circumstances he must introduce a piece of iron with the acid and the base into his charge, for the patentee himself did not know that iron was necessary. Thus, by the invention of the enamelled digester, the specification, sufficient for the full description of the process so long as only bare iron digesters were available, has become fatally insufficient now that an operator is more likely as a mere matter of chance to be provided with an enamelled digester, than with an unlined one. What is the patentee to do? It does not help him to disclaim, the fault is not in the claim, but in the description. It is not a case for explanation. Explanation means the explanation of some obscurity in the original language, so as to let the original meaning shine through. Here the difficulty is that the patentee originally meant to say exactly what he has said. It was his own apprehension of the invention that was at fault, not his expression of what he meant. Still the misapprehension was not of a kind which in our law vitiates in patent. A patentee may hold the wildest theoretical notions and yet prepare a perfectly sufficient specification if he defines with accuracy the practically necessary steps for carrying out his invention. A patent for a sextant would not be bad because the inventor thought it an instrument for measuring the movement of the sun in an orbit round the earth, and so described it. His geocentric view of the solar system would be a mere irrelevancy and quite innocuous to his patent right, however obtrusively he put it in the forefront of his description. Our present patentee's mistake is of the same innocent kind so long as the mention of a digester sends people to the use of an implement of unlined iron. There clearly ought to be some way of enabling the patentee to amplify his specification when he finds out his mistake by saying in effect, "Now that you can obtain enamelled digesters, take note that what I said originally only applies with the qualification that the digester must be made of iron and unlined. If you use the lined vessel, add iron to the charge." That makes the specification mean for practical purposes in future precisely what it has meant in the past, and on any principle on which amendment can be justified at all such must be a legitimate amendment. But it is not any kind of "disclaimer, correction, or explanation," and therefore it is not within the scope of the Sections (21 and 22), which expressly provide the machinery and processes of amendment.

A scheme of amendment by successive complete specifications designed to provide for such a case as this has long been publicly advocated by Sir Lloyd Wise, and it may well be, that patents of addition will be adapted to the supply of a power of amendment of this kind. It is quite doubtful upon the language of the Act itself wherein the subject-matter of a patent of addition must consist. The Section (19) says, "any improvement in or modification of the the invention" the subject of the principal grant. In terms, at least, it is not provided that the subject-matter of a patent of addition must be an independent invention. The view that any improvement or modification, however unsubstantial or however well-known, may really be the subject of a separate patent grant is not easily adopted, but on the other hand there is, as we have seen, no possible theory of the nature of patents of addition in the form given to them by the statute, which does not bristle with difficulties. If, then, we make the bold assumption that the patentable novelty of the subject-matter of a patent of addition may be found in the original invention, and that only such novelty must attach to the improvement or modification as will give it a separate identity, we should be able to discover in this somewhat inscrutable device the means of providing machinery for enabling patentees to amend insufficient specifications by amplification. But the whole subject of patents of addition must be the work of the Comptroller-General, for what we find in the Act of Parliament is mere plastic material, not yet wrought up into the likness of anything in the heaven above or in the earth beneath, or in the waters under the earth.

I have now passed in rapid review the principal features of the new Act, and it will be seen that while much ground has been covered and a beginning made in many directions the Act itself contains little beyond foundations. The superstructure of the real Patent-law will have to be built on to these foundations by judges and administrative officers. But even, considered as foundation,

the new statute does not supply a complete plan. When I addressed you on a former occasion I took the opportunity to draw attention to what is, to my own mind, by far the most serious defect in our system of Patent-law, that is to say, its want of adaptation to the requirements of the British Empire as a whole. The only machinery of any kind which the present Acts contain for facilitating the acquisition of patent rights by a dweller in any part of the British Empire outside the dominion in which he may chance to dwell, is a strangely inapt appliance called the "International Convention," and so called because, as originally drawn up, it was designed to provide for the reciprocal concession of facilities for the acquisition of patent rights between the peoples of Belgium, Brazil, and some eight or ten other countries in various parts of the world. It would be a shameful thing that nothing better adapted to the domestic requirements of the British Empire should have ever been devised if the fact were so; it is doubly shameful that, an indigenous Imperial scheme having been devised in 1852, and largely brought into use in the succeeding quarter of a century, that grand work should have been cast down in 1883, and this exotic plant substituted in its stead. The result of that achievement has been that one by one our colonies have followed our example, so that now the expense and difficulty to a British inventor of getting the protection of patent right throughout the British Empire is quite comparable to that of obtaining patent rights in all the remaining countries of the world taken together. It is not at all to be wondered at that in the legislation of last session that matter, important as it is, should have been left untouched. There was no popular demand for legislation on these lines, and no general recognition of the want which has to be supplied. At present the demand for an Imperial Patent-law is a fad. But I will ask leave to put on record my own sanguine hope that at some future time, and that in a future not remote, this Society, when deliberating again upon this subject, may find that both at home and over seas the men of our race and the dwellers beneath our flag have come to see that in a well-considered Patent-law Convention of the British Empire there lies the greatest possibility, at present undeveloped, of making patent rights promote the spread of industries throughout the Empire, and foster the growth of its internal trade.

DISCUSSION.

The Chairman (Sir William Preece), in opening the discussion, said that those who were present at the Society on the 30th November, 1906, would remember the masterly way in which the author dealt with the condition of the Patent-law at that time. He had, with equal skill, given in the present paper a critical abstract of the Act, which was passed in such a phenomenal way through the Houses of Parliament last year. There were many remarkable features in that Act to which he desired to refer, the first essential one being the enforcement of compulsory working of a patent in this country, whether taken out in the future, or whether existing from the past. He knew, as a fact, that those clauses in the Act had already taken an active form, because many factories were now being erected by foreign manufacturers in Manchester and other places, to enable them to work under the patents they held in this country, so that it was evident that the Act had already begun to tell for the welfare of this land. One defect in the Act apparently was the absence of a compulsory search for priority. This country in that respect was not in so strong a position yet as Germany or the United States. On the other hand, the Act had reduced the cost of taking out a patent to a smaller figure than that in any other great country. In addition to that the cost of litigation was reduced, which was distinctly one of the main features that influenced the Board of Trade in bringing forward the Act last Session. The Act, however, did not meet the case where an applicant for a patent was bothered by some vexatious claim by somebody with an imaginary anticipation. There was a class of cranks, well known to patent agents, whose sole object appeared to be to lodge claims for priority on absolutely no justification whatever. They delayed the issue of the patent, and caused a great deal of trouble, as well as expense. If such people were promptly mulcted in costs he thought the number of those vexatious appeals would be diminished. While the Act was very good in its way it was not perfect, and he did not see how it was possible in the present day, with party politics, for anything to be made perfect; but it was very remarkable that in spite of the state of political parties the Bill was carried through the House with very little trouble. The term of 14 years had been retained, although some people had hoped that the American term of 17 years would have been introduced. However, the new Act was an Act of statesmanship which reflected the highest credit on his distinguished countryman who presided at the Board of Trade. Throughout the whole of the proceedings in Parliament, and since, Mr. Lloyd-George had shown that he had grasped the whole subject, and had carried the Bill through the House with an amount of tact for which he deserved all credit. One point to which the author had not referred in very eulogistic terms must not be forgotten, viz., that a patent must be regarded as a contract between the Government, who gave the

patentee a very profitable asset, and the patentee who secured a species of monopoly; and it was only right and fair that the Government in bringing forward an Act should be enabled to exact from the parties to whom a property was given something in the shape of service for the British public. In fact, the Act was very much of a kind of protection. It was not, however, protection that affected the food of the people, but which enlarged the bill of labour. It would do what the same kind of Bill had done in other countries—attract capital to this country. The Patent-laws in America and Germany had forced British manufacturers to spend their capital in those countries in the establishment of industries there, and American and German capital in the same way must infallibly come over to this country in order to comply with the conditions of the Act.

Mr. WALTER F. REID, F.I.C., said that those who had been interested in the patent question for many years must feel satisfied that at last such an Act had been passed. Whatever it was it seemed to give British patentees a right they had not hitherto possessed; and it gave to manufacturers and others engaged in industrial pursuits in this country a similar right, that they should be entitled to use foreign patents which were taken out in the country, thus conferring a monopoly upon their holders. That was really the mainspring of the agitation which resulted from the Act of 1902. The author had called the present Act the "Manchester proposal." Personally he objected to that term as being too local. The agitation was to a great extent due to a distinguished inhabitant of the Manchester district, Mr. Ivan Levinstein, who worked very hard and spent much money on testing the old law as it existed. He spent thousands of pounds in trying to get a compulsory license, and the operation lasted so many years, that the utility of the license, if he had obtained it, would have been *nil*. A deputation waited on Mr. Lloyd-George, who not only grasped all the points put before him by the deputation, but he seemed to have grasped other points too, which he had put into the Bill. He did not recollect the question of additional patents being pressed strongly upon Mr. Lloyd-George, even if it was mentioned at all; but they certainly did not want the German Zusatzpatent. He had no hesitation in saying that the present Act would do British inventors and British industry a great deal of good. Very great power, however, had been put into the hands of the Comptroller, and he hoped it would not be used in such a way as to countenance objections. It was well known that some of the objections in the Patent Office to trade marks were absolutely childish, and if that sort of thing was to happen with regard to patents, the sooner another Act was passed doing away with the control of the Comptroller the better it would be. The author had mentioned the utilisation of water-power for the fixation of the nitrogen of the air. It might interest Mr. Gordon to know that water-power had not such a monopoly of the industry as had hitherto been supposed, because a large company would shortly be at work which would utilise coal for the same purpose, in the confident belief that coal, under certain conditions, could commercially compete with water-power. A properly constructed power-gas plant might well compete with water-power, so that a patent, apparently dependent upon the latter, might nevertheless become of considerable commercial value. There was one extremely important reason why such a patent should not be controlled by foreign countries, but that the working should be compulsory in this country, viz., that England was at the present time entirely dependent for its explosives on foreign countries. Not an ounce of explosives could be made in England under the ordinary commercial conditions without using nitrate of soda obtained from abroad. That was not a satisfactory state of things, because this country might be cut off from obtaining a supply of such an important ingredient. It could be made from the air, but if a foreign monopoly in this country prevented that being done here the industry would be established abroad, and if the necessity arose for nitrates being made here, there would be no factory established for the purpose. The author had mentioned that small manufacturers could not afford to search the files at the Patent Office to ascertain what patents were being taken out; but that was done very well for them in most trades and industries by the technical literature, so that very few manufacturers need be without a clear and definite account of patents and improvements in the particular industries in which they were interested. This was especially the case in the chemical industry. He differed from Mr. Gordon in the case he mentioned with regard to the iron autoclave. He did not say there might not be cases where an inventor unknowingly omitted some essential feature of his invention, and consequently ought to have the right to make a small addition which rendered his patent complete. There the new law would be a very great advantages. In the case quoted, however, the inventor ought to have specified in his patent, to make it a good one, that he used an iron digester to carry out the operation, because it was a contract between him and the public; and if he did not tell the public how the operation was carried out and the product obtained, his part of the contract was not complete, and he ought not to obtain his patent. A similar case occurred with regard to aluminium, Mr. Watson Smith discovering that the supposed effects of different liquids on aluminium were due simply to the alkali derived from glass vessels in which the experiments had been carried out. He thought in such a case the patentee should have mentioned the material of which the vessel was composed; it was very usual to do so in chemical patents. The Society was not a political one, and, therefore, it was inadvisable to discuss the general question of Protection; but if the Act was not a protection in connec-

tion with the food of the people, it certainly was protection for the money and the industry by which they bought their food. He thought it was thoroughly justified, and heartily congratulated the President of the Board of Trade on having passed such a very useful Act. When two or three years' experience of it had been obtained, he trusted that Mr. Lloyd-George, or his successor, would be equally ready to give effect to all the amendments which might be found necessary. It might also be of interest to state that before the rules were published, they were circulated among a number of technical societies for their opinion, and modified in accordance with the information thus received by the Board of Trade. That was a very good departure, which, if more frequently adopted by Government departments, would result in less grumbling by the country in general on some legislation that was carried.

Mr. J. F. ISELIN said he was afraid he was not in harmony with the previous speakers as to the effect of the Act, which contained two important points. The first, which was the most important, was the forfeiture of a patent for want of working, and the second the power of the Comptroller to refuse a patent altogether. On those points he desired to enter a very strong caveat against the Act. A few months ago all the world was falling over each other in claiming that there should be provisions in the Act for forfeiture of patents for want of working. He ventured to think a few years hence the descendants of those same persons would be running away in the endeavour to escape the curses of the widows and orphans of the unfortunate inventors who had been deprived of their livelihood by those same provisions. A great deal of Protectionism and hatred of the foreigner had been imported into the question, and in order to avoid that he desired simply to refer to the case of the unfortunate British inventor, because his position was no better and no worse than that of the foreign inventor under the new Act. For instance, a man who made an invention which was useful only to one manufacturer might be told if he went to the manufacturer, "You have no capital to work this invention; why should I pay for it? In four years' time the invention will fall into my hands, because you cannot work it in this country." That was not limited to the case of a man whose invention was useful to only one manufacturer, because in the case of three or four what was to prevent them from entering into a ring against the inventor? There was nothing as far as he could see. He thought the introduction of forfeiture for not working the patent was a very dangerous thing. He believed—and the best opinion in Germany was coming round to the same view—that exactly the same benefits could be obtained by means of a system of compulsory licensing. As an example which came under his own notice, he knew that under the Act of 1902, an action was brought for a compulsory license against the Shoe Machinery Trust, which resisted the endeavour to obtain a license until the case was taken to the Privy Council, and when it was actually in the paper for hearing they gave way and accepted the conditions offered. Statesmen should by all means insist, if they wished, that patents should be worked in this country, but he submitted it was not right that the burden of it should fall entirely upon the unfortunate inventor, who might be a poor man. He submitted also that it was a very dangerous proceeding to give power to the Comptroller to refuse a patent altogether. When the system of preliminary examination was introduced into this country it was claimed, with justice, that it had avoided the disadvantages of the German system in that an invention which was so original that the officials in the Patent Office could not say that it was an invention, was entitled to its patent in spite of all the world. It might be that those inventions were not many, but nevertheless they existed, and the experience of the German law should have shown this country that it was highly dangerous to give to any man, however wise he might be, the power to refuse a patent absolutely. He submitted, confidently, that it would have been wise to have remained by the provisions of the Act of 1902, and to have allowed a man to take a patent at his own risk. It was known that the agitation for compulsory working was directed against the German chemical manufacturers, and in respect to them he believed the agitation would entirely fail. The motive power of the agitation was the desire of certain persons to have the advantages of certain German chemical inventions without paying for them. As far as he could see the result would only be to bring German competition into this country. A few British workmen might have additional wages, but none of the profits of manufacture would remain in this country, nor was it likely that British chemists would enjoy additional wages from the introduction of German chemical manufactures here. He had the good fortune, a few months ago, to be shown over one of the great German manufactories, and it was extraordinarily interesting to notice the completeness of the system which was adopted to prevent any visitor from obtaining any inkling of the processes of manufacture. Indeed, one of the directors of the works told him that every chemical used was not called by its proper name but by another one, in order that the workmen should have no knowledge o the process of manufacture.

Mr. H. FLETCHER MOULTON thought it was not difficult to point out both sins of commission and omission in the new Act. Like the last speaker he was considerably afraid of the compulsory working proposals, not because he thought the patents ought not to be worked in this country, but because the Act abandoned the very obvious and proper system of compulsory license in order to try and force the starting of the working of the invention simultaneously in all the countries of the world, which was in most cases a practical

impossibility. The only reason which could be suggested for such a procedure was that other countries were trying it, and that England might just as well be forward in the race; but it was perfectly impossible in practice to expect that a complicated invention like the linotype machine, for instance, could be manufactured in three or four years in a dozen different countries. The Legislature had before them a perfect test in the compulsory license as to whether an inventor was really utilising the resources of the country. It might be the case that the procedure for getting a compulsory license was expensive in the old days; the proper step was to simplify it, but the Act had neglected it. Terrible tales were heard of the failure of the compulsory license, for instance, there was the case of the Manchester man who failed to get a compulsory license, but it was not always pointed out that that was because the patent under which he would have liked a license was specially exempted from the Bill of 1883. In his opinion it would be difficult to find a good case for a compulsory license which had not been granted. What really happened in the shoe machinery case, to which Mr. Iselin referred, was that terms were offered which the petitioners knew it would be absurd to refuse and go on with the petition; and when they had to choose, they took the old license. He very much regretted that, instead of trying to improve the machinery of the compulsory license, it had been pushed to the background. The same remark applied to that extraordinary clause 38, dealing with restrictive covenants. The introducer of the Bill did not seem to realise that he was handicapping, not so much the patentee, ut the person who wanted to get a license under it, by saying that no licenses should be granted on the terms that all the machinery was to be taken from one particular man. That did not handicap the man who sold so much as the man who was buying, and who could afford to take the whole of the machinery in order to get it at a cheaper price. It was perfectly true that at the eleventh hour a proviso was introduced with a view of giving liberty to the buyer to get the best terms, but it was only half-heartedly done, and it was doubtful if it car out its purpose. With regard to the sins of omission, first of all a Bill was passed followed by a Consolidation Bill so close on its heels that there was no time to amend any defects which the first Bill revealed; in fact, the latter Bill was so hurriedly passed through that it was unable to carry out the former effects of the law. A very great deal, at any rate from the theoretical lawyer's point of view, might have been dealt with that was omitted. For instance, the very difficult question of the rights of co-patentees had not been more than scratched at by the Act. It was laid down that a man might assign his share of a patent, but might not grant a license without the leave of his co-patentee; but no attempt was made to deal with licensing by assigning a nominal share; while what would happen in a case of death was entirely a subject for future litigation. He heard the Act described by Sir Joseph Lawrence at the Imperial Industries' Club as a layman's Act. The author and many others present remembered with gratitude other laymen's Acts, such as the Workman's Compensation Act, which had provided a very deserving class with their living for some years past, and he trusted the new Patent Act would have the same effect.

Mr. GORDON, in reply, after thanking the audience for the kind manner in which they had received his paper, said the suggestion had been made that the new Act was a Protectionist measure. He thought that on reflection Mr. Reid, and those who thought with him, would come to the conclusion that it was not Protectionist at all, the reason being that the Act was designed to limit privilege, and not to establish it, while Protection was in the nature of a privilege. He had been exceedingly interested to hear what Mr. Reid had said with regard to nitrogen fixation, because although he remembered hearing a vague statement of the kind some time ago, he did not suppose at the time that it was at all possible. It was minently desirable that nitrates should be produced in the country; indeed, he would go further and say that for the purpose of securing a supply of explosives, for instance, which should be available in all circumstances, it should be undertaken as a national business, just as the manufacture of ordinance and small arms was carried out by a Government department. To suppose that such a necessity could be provided for by the haphazard system of regulating the Patent-law was a suggestion that would not, he was sure, commend itself to Mr. Reid. In the case of the iron autoclave, it was always very difficult to find a case which was actually a fact and a case in point, and that was why he said in dealing with the case he would take the opportunity to be very highly imaginative. He postulated for the purpose of making his point that unlined autoclaves were the only autoclaves obtainable, so that the mere prescription "autoclave" would be sufficient for it to be known that it was an iron receptacle, as at the date of the specification a lined receptacle had not come into use. So that he made the point with which Mr. Reid did not credit him, that in the specification as it originally stood the use of iron was prescribed, although the inventor did not know he was prescribing it. With regard to Mr. Iselin's remarks, he was very far from wishing to pose as the apologist for the system of compulsory working, being fully aware of the drawbacks and dangers which attended any such system. He did not think either Mr. Iselin or Mr. Moulton had heard the passage in the paper which dealt with that point, and therefore he did not know whether they would have joined issue with him on it. Both those gentlemen took, as he thought, rather too strong

a view of what the provisions of tbe Act were. As it appeared to him, they were simply preparatory. Machinery was laid down, but whether, as Mr. Moulton said, it would supersede the system of compulsory licensing, or, as Mr. Iselin said, it would reduce the deserving inventor to beggary, depended on how things were worked. It would not be the result of the Act, because that was vagueness itself upon the subject. The machinery might work in any one of a great number of different ways; but the way in which it worked would depend upon the amount of insight and judgment brought to bear upon it by the administrative officers who carried it out, and that was why he said that the operation of the system must be an object of very careful attention for some years to come by all who were interested in the working of the patent system. He hoped inventors and learned societies (especially trade societies) would very narrowly watch the proceedings of the Patent Office, and judge with regard to the working out of the system. If it was properly worked out, he thought there need be no hardship or injury; but there were possibilities of very serious mischief in the system if it was badly administered. The same remark applied to the Comptroller's power of refusal. The idea with which the clause was put into the Patent Act was that it would be used only in a very limited number of cases—cases that were absolutely clear. The provisions of the Act were that, where it was found that an invention claimed as the subject of a new patent had been specifically and completely claimed in a previous patent, the Comptroller was at liberty to refuse the patent. It was difficult to suppose that, if the two claims were indistinguishably alike, there could be any serious objection to a power of refusal used in those circumstances. Whether that would be the way in which the Act would work, must depend upon the judgment, discretion, and ability with which the administration carried it into effect; and being by nature an optimist he hoped for the best.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Gordon for his excellent paper, and the meeting terminated.

HOME INDUSTRIES.

The Settlement of the Cotton Dispute.—The hope expressed in these Notes last week that "the cotton trade dispute will afford another illustration of common-sense winning the day" has been fulfilled, the dispute between emgloyers and workpeople has been settled, and relations are again normal. It was said here last week that "the cardroom amalgamation officials have already expressed their willingness to acknowledge the Brooklands agreement as binding on the ring-spinners after a universal list has been completed, and it is difficult to understand why such an arrangement should not be made before a list is discussed." The employers have not moved from the position they took up in their letter of January 10 when the differences between the employers and operatives had been narrowed down to the question whether the ring-spinners were or were not bound by the terms of the Brooklands agreement. In that letter the employers intimated that they could not consent to negotiate under conditions which implied the setting aside of the Brooklands agreement, or agree to the assumption that ring-spinners are not at present under the agreement, and to that decision they have stood. The operatives have wisely given way, and probably their leaders would have done so much earlier in the dispute if they had had an entirely free hand. The employers have gained the essential point for which they strove from the outset, and the operatives express themselves satisfied with the admission by the employers that acceptance of their letter of January 10 does not deprive them of any of their rights in connection with the framing of a universal list. Nothing of this kind has been said before on the employers' side, and the operatives consider that the negotiations have not been in vain since they have won this point for the ring-spinners. It must of course be borne in mind that the danger of disagreement will not be entirely removed until the negotiations with regard to the ring-spinners' wages are satisfactorily ended, but assuming, as it is reasonable to do, that there is a genuine desire on both sides to arrive at a fair settlement, it may be confidently hoped that now the matters to be settled have been reduced to questions of shillings and pence, and the standardising of varying conditions, all outstanding difficulties will be satisfactorily settled.

Railway Conciliation.—It is encouraging to have the assurance of the President of the Board of Trade that the railway conciliation scheme is making excellent headway. All the railways of Wales, Scotland, and Ireland are joining England. Most of the English railways are already in. There are only 25 companies outside the scheme of conciliation, and the total number of people they employ between them is 1,400. A good deal will depend, of course, upon the spirit in which the scheme is acted upon, but if it is one of conciliation, as no doubt it will be, the scheme will be a success, and a guarantee that for seven years, at any rate, there will be no serious railway labour trouble.

The New Patent Act.—It is seldom that an Act of Parliament has such an immediate and beneficial effect as that which seems likely to follow upon the coming into operation of the New Patent Act. Many foreign patentees are already negotiating with British manufacturers to carry out in the United Kingdom their British patents. Others have taken land for the purpose of erecting works in order themselves to work their British manufactures. As was recently mentioned in these Notes (*Journal*, January 3rd) the Höschst Farbwerke (formerly Meister, Lucius and

Brüning) with whom are allied Messrs. Cassilla and Co., have intimated their intention to commence manufacturing in England, and have secured land for the erection of works at Ellesmere Port, near Chester. These two companies represent a capital the market value of which amounts to more than eight millions sterling. The Elberfeld Farburfabriken, with whom are associated the Badische Aniline and Soda Works, and the Berlin Company, with a capital of over £13,000,000, intend to erect works for the manufacture in this country of all the products for which they hold British patents. Their chief representatives have been over from Germany to make inquiry for suitable land, and probably the new works will be erected in the neighbourhood of Manchester. These companies also hold British patents for the manufacture of synthetic indigo and many alizarine colours. A well-known American company which holds British patents for the manufacture of safety razors, hitherto made solely in the States, have secured land in Sheffield, and expect to employ 500 hands as soon as their works are completed. Many other foreign manufacturers holding British patents, which they have hitherto worked solely abroad, are following their example. There is not the slightest doubt, writes Mr. Svan Levinstein, in an interesting letter directing attention to what the new Act has already brought about, that the advent of these foreign manufacturers will mean additional employment for workers—the operative classes, highly trained engineers and chemists—and give a new impetus to British enterprise. Unlike its predecessor, the new Act is clearly worded, and leaves no loopholes for escape from its salutary and much-needed provisions.

Fruit Cultivation.—The agricultural statistics for 1907, just issued, show that the contraction in the area of cultivation in Great Britain, which has been such a disturbing feature of the rural position for many years past, continues. In 1907 the reduction was 23,000 acres, and there was a further reduction of arable land by 56,000 acres, bringing the total for the first time below 15 million acres (14,966,000). The reduction during the past 30 years has proceeded, with comparatively slight yearly fluctuation, at the rate of about 1 million acres per decade. Notwithstanding the reduction of the land under the plough, the total extent of arable land actually under crop was almost the same as in 1906, owing to the fact that 53,000 acres less were left as bare fallow. In the returns now presented the principal addition is to be found in details relating to the cultivation of fruit so as to enable some estimate to be made of the relative importance of the principal sorts of fruit grown in Great Britain. It is satisfactory to find that, as compared with 1906, there is an increase of 1,949 acres under small fruit, and of 2,489 acres under orchards, or if a longer period is taken, an increase is shown during the past 10 years of 12,000 acres of small fruit and 25,000 acres of orchards. Taking the whole of Great Britain it will be found that there are no less than 27,826 acres in strawberries, 8,878 in raspberries, and 25,590 acres in currants and gooseberries.

Horse Breeding.—Only cold comfort is to be found in the statistics as to horses in the volume just issued. Earl Carrington recently pointed out, and in doing so did no more than repeat what many authorities in a less responsible position have said that the dearth of foals in this country is a national danger. Lately the number has diminished by 10,000 in a single year. To quote the Secretary of the Hunters' Improvement Society, France, Austria and Germany recognise the importance of maintaining the numerical strength and quality of their horses and each spends £200,000 a year in this direction. Under existing conditions foreigners come over here and buy all the best of our brood mares. That is the crux of the whole question. In some districts there are no good animals left at all; they have been secured by other countries. The Dutch Government alone took from Ireland recently 350 of her best brood mares. Last year, according to the returns, the total number of horses showed a further decline of 12,312, reducing the total to about the same as in 1904. The largest actual reductions appeared in Lincoln, 1,172; the East Riding, 946; and Suffolk, 896. All but six of the English counties, and most of the Scottish, showed decreases, but Wales had a slight increase. The number of horses used for agricultural purposes was practically the same as in 1906, but the county figures reveal rather striking diversity. Thus in the Eastern, or typically arable section of England, there was a decline of nearly 3,300 agricultural horses, while in the Western, or grazing section, and Wales, there was an increase of about 3,000. The greatest part of the decrease occurred in the youngest class, namely, unbroken horses under one year old, which were 10,451, or 7·6 per cent. fewer than in 1906. The total now recorded, 126,490, is the smallest since 1900. As these figures afford the best indication of the progress of horse-breeding, the substantial decline shown in the returns is significant. In all parts of the country they tell practically the same tale. In Great Britain as a whole the total is the smallest since 1900, and in England alone it is the smallest on record, *i.e.*, since this class was first separately distinguished in 1896. In Scotland, where the increase of horse-breeding from 1900 to 1906 was relatively much greater than in England and Wales the numbers are reduced to the level of 1903, but are still considerably above those of previous years, while in Wales the numbers still remain larger than in any years prior to 1904. Expressed in percentage the loss in 1907 as compared with 1906 was in England 10 per cent., in Scotland 7 per cent., and in Wales 2 per cent. Among the causes assigned by the collectors for this reduction of young stock, severe weather during the foaling season, and the effect of motors on light horse-breeding, are most commonly mentioned.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 5.—"War Balloons." By AUGUSTE E. GAUDRON. The HON. CHARLES STEWART ROLLS will preside.

FEBRUARY 12.—"The Application of Science to Foundry Work." By ROBERT BUCHANAN, President, Staffordshire Iron and Steel Institute. H. GRAHAM HARRIS, Member of Council, will preside.

FEBRUARY 19.—"The Law of Treasure Trove." By WILLIAM MARTIN, M.A., LL.D.

FEBRUARY 26.—"The Problem of Road Construction, with a View to Present and Future Requirements." By PROF. H. S. HELE-SHAW, LL.D., F.R.S., and DOUGLAS MACKENZIE. The HON. RICHARD CLERE PARSONS will preside.

MARCH 4. — "Modern Dairy Practice." By LOUDON M. DOUGLAS.

MARCH 11.—"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By ERNEST R. MATTHEWS, F.R.S.E., Assoc.M.Inst.C.E.

MARCH 18.—"Impressionist Painting: its Genesis and Development." By WYNFORD DEWHURST, R.B.A.

Dates to be hereafter announced:—

"Recent Improvements in Decorators' Materials." By A. S. JENNINGS.

"The Underground Water Supplies of the Thames Basin." By CLAYTON BEADLE.

"Industrial Entomology: the Economic Importance of a Study of Insect Life." By F. MARTIN DUNCAN.

"The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 13.—"The New 'Imperial Gazetteer of India.'" By RICHARD BURN, I.C.S. (To be read by WILLIAM FOSTER.)

MARCH 12.—"Progress of Native States during the past Forty Years." By SIR DAVID W. K. BARR, K.C.S.I., Vice-President of the Council of India.

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

FEBRUARY 25. — "Irrigation in Egypt under British Direction." By SIR HANBURY BROWN, K.C.M.G. The EARL OF CROMER, O.M., G.C.B., G.C.M.G., K.C.S.I., will preside.

MARCH 24.—"The Mineral Resources of Western Australia." By the HON. C. H. RASON, Agent-General for Western Australia.

APRIL 7.—"The Imperial Problem of Asiatic Immigration." By RICHARD JEBB.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

FEBRUARY 18.—"Banners in Pageantry." By GEORGE W. EVE. WALTER CRANE, R.W.S., will preside.

MARCH 31.—"Enamel Portraits." By CYRIL DAVENPORT, F.S.A. SIR HUBERT VON HERKOMER, C.V.O., R.A., will preside.

APRIL 28.—"Lace as a Modern Industry." By Miss ISEMONGER.

MAY 26.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

HENRY HARDINGE CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." Six Lectures.

LECTURE III.—FEBRUARY 3.—The simple pendulum concluded — The compound pendulum — General formula—Moment of inertia—Corrections for circular error, and for moment of inertia of bob—Air buoyancy, its effect on pendulums.

LECTURE IV.—FEBRUARY 10.—Method of compensating pendulums for the expansion of the rod, the bob, and the temperature of the air—Barometric correction—Method of construction of pendulum—The gridiron, the mercury, the zinc and steel, lever and other pendulums.

LECTURE V.—FEBRUARY 17.—The pendulum continued—Modes of suspension—Air-tight cases—The escapement—Principle of the escapement; effect of disturbances—The dead-beat escapement—Detached escapements and gravity escapements—The escapements of Mudge, Cummings, Bloxam, and Denison.

LECTURE VI.—FEBRUARY 24.—The theory of escapements concluded—Teeth of wheels—The theory of epicycloidal teeth — Involute teeth — Lantern pinions—Electric clocks—Main divisions of electric clocks—Difficulties to be contended with—The clock of the future.

PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." Four Lectures.

March 9, 16, 23, 30.

WILLIAM BURTON, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.

May 4, 11, 18.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

Tuesday and Friday evenings at 8 o'clock:—

FEBRUARY 7.—"The Hygiene of the Pottery Trade." By WILLIAM BURTON, F.C.S., Chairman of the Joint Committee of Pottery Manufacturers of Great Britain.

February 28.—"The Removal of Dust and Fumes in Factories." By John Scott Haldane, M.A., M.D., M.R.C.P. (Edin.), F.R.S.

March 17 (Tuesday).—"Child Workers and Wage Earners." By Miss Nettie Adler, Hon. Secretary to the Committee on Wage Earning Children.

May 15.—"The Dangers of Coal Dust and their Prevention." By W. E. Garforth, President of the Colliery Proprietors' Association of Great Britain.

Howard Lectures.

Thursday evenings, at 8 o'clock :—

H. S. Hele-Shaw, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

March 19, 26, April 2.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 3...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture). Mr. Henry Hardinge Cunynghame, C.B., "The Theory and Practice of Clock Making." (Lecture III.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Inaugural Address by the President, Mr. J. W. Wilson.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Lieut.-Col. Sir Frederick Nathan and Mr. W. Rintoul, "Nitro-glycerine and its Manufacture."

British Architects, 9, Conduit-street, W., 8 p.m. Address to Students by Prof. W. R. Lethaby

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. C. Dillworth Fox, "The Southern Alps of New Zealand and their Glaciers."

London Institution, Finsbury-circus, E.C., 5 p.m. Prof. W. B. Bottomley, "Soil Inoculation."

Tuesday, Feb. 4...Royal Institution, Albemarle-street, W., 3 p.m. Prof. F. J. Haverfield, "Roman Britain." (Lecture II.—"Its Interior Civilisation.")

Alpine Club, 23, Savile-row, W., 8½ p.m

Designers, 6½, Suffolk-street, Pall Mall, S.W., 8 p.m. Sir Edward Sullivan, "Design in Ornamental Bookbinding."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussions on the following papers:—1. Sir John W. Ottley and Dr. Arthur W. Bright more, C.E., "Experimental Investigations of the Stresses in Masonry Dams Subjected to Water Pressure." 2. Messrs. John S. Wilson and William Gore, "Stresses in Dams: An Experimental Investigation by means of India-rubber Models." 3. Mr. Ernest Prescot Hill, C.E., "Stresses in Masonry Dams."

Zoological, 3, Hanover-square, W., 8½ p.m.

Wednesday, Feb. 5...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Auguste E. Gaudron, "War Balloons."

Geological, Burlington-house, W., 8 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Rev. T. J. Lawrence, "The Hague Conference and Naval War."

Royal Archæological Institute, 20, Hanover-square, W., 4½ p.m. Mr. A. Hartshorne, "Holdenby House and Church."

Thursday, Feb. 6...Royal, Burlington-house, W., 4½ p m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Clement Reid, "Fruits and Seeds from the Pre-Glacial Beds of Britain and the Netherlands." 2. Mrs. Reid, "A Method of Disintegrating Peat and other Deposits containing Fossil Seeds." 3. Mr. S. T. Dunn, "A Botanical Expedition to Fokien."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. O. Silberrad and H. A. Phillips, "The Metallic Picrates." 2. Messrs. R. Robinson and F. S. Kipping, "Organic Derivatives of Silicon (Part 5), Benzylethylsilicone, Dibenzylsilicone and other benzyl- and benzylethyl-derivatives of Silicane." 3. Messrs. H. Hartley, N. G. Thomas, and M. P. Applebey, "Some Physico-Chemical Properties of Mixtures of Pyridine and Water." 4. Mr. F. Tutin, "The Constitution of Umbellulone" (Part III). 5. Mr. A. Clayton, "The Residual Affinity of the coumarins and thiocoumarins as shown by their additive compounds." 6. Messrs. H. M. Dawson and C. G. Jackson, "The Influence of Foreign Substances on Certain Transition Temperatures and the Determination of Molecular Weights." 7. Miss A. E. Smith and Mr. K. J. P. Orton, "The Bromination of P-hydroxydiphenylamine." 8. Mr. F. G. Pope, "Colour and Constitution of Az-methine Compounds" (Part 1). 9. Mr. W. M. Hooton, "The Decomposition of Ammonium Bichromate by Heat" (Preliminary notice).

London Institution, Finsbury-circus, E.C., 6 p.m. Sir Frederick Bridge, "Two Noble Brothers (William and Henry Lawes)," with Illustrations by Westminster Abbey Choristers.

Royal Institution, Albemarle-street, W., 3 p.m. Major Martin Hume, "The Story of the Spanish Armada." (Lecture II.)

Civil and Mechanical Engineers, Caxton-hall Westminster, S.W., 8 p.m. Mr. F. G. Woollard, "Some Devices for the Absorption of Shock on Wheeled Vehicles."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. S. Peck, "Protective Devices for High-tension Transmission Circuits."

Friday, Feb. 7...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Shaw Lecture on Industrial Hygiene.) Mr. William Burton, "The Hygiene of the Pottery Trade."

Royal Institution, Albemarle-street, W., 9 p.m. Mr. Humphry Ward, "Napoleon and the Louvre."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. P. T. Steinthal, "Electric Hardening and Annealing Furnaces."

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m.

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. C. Harrison Townsend, "Garages and Motor Houses."

Geologists' Association, University College, W.C., 7½ p.m. Annual Meeting. Address by the President on "The Centenary of the Geological Society."

Junior Institute of Engineers, United Service Institution, Whitehall, S.W., 8 p.m. Mr. H. Chatley, "Aerial Navigation."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, Feb. 8...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Lionel Cust, "Anthony Van Dyck." (Lecture II.)

Journal of the Royal Society of Arts

No. 2,881. VOL. LVI.

FRIDAY, FEBRUARY 7, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

H.M. KING CARLOS OF PORTUGAL.

His Majesty, the late King of Portugal, whose death by assassination on Saturday last, the 1st February, is deplored in this country almost as deeply as in his own, was an Honorary Royal Member of the Society. His Majesty was elected in 1905, when on a visit to England, where he was well known and deservedly popular.

NEXT WEEK.

MONDAY, FEBRUARY 10, 8 p.m. (Cantor Lecture.) H. H. CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." (Lecture IV.)

WEDNESDAY, FEBRUARY 12, 8 p.m. (Ordinary Meeting.) ROBERT BUCHANAN, "The Application of Science to Foundry Work."

THURSDAY, FEBRUARY 13, 4.30 p.m. (Indian Section.) RICHARD BURN, I.C.S., "The New 'Imperial Gazetteer of India'."

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 3rd instant, Mr. H. H. CUNYNGHAME, C.B., delivered the third lecture of his course on "Theory and Practice of Clock Making."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evening, January 21st; H. H. CUNYNGHAME, C.B., in the chair.

The paper read was—

DEVELOPMENTS IN THE ART OF JEWELLERY.

By MRS. HADAWAY.

It is eighteen years since an excellent paper by Mr. Carlo Giuliano was read here, in which a very comprehensive view of the history of jewellery was given. I will not go over that ground again, as with the exception of a few allusions to the past, it is of the jewellery of the present day that I will speak.

It is perhaps strange that the art of the goldsmith and jeweller, an art so romantic and alluring, should have become what it is now—a dull and stereotyped commercial business. Jewellery is produced, like other hideous manufactured things, by people who know nothing of art, and whose only care is to turn out as many saleable articles as possible. There are a few artists who are doing their best to show that a jewel may still be an object of beauty in which thought and individuality are shown. But compared with the thousands engaged in the jewellery trade, they are a mere handful. It is of these artists and their work chiefly that I am going to speak. Of course, public taste controls to a great extent the kind of jewellery that is produced. And the commercial article now holds the field. This is partly, too, because the large firms of manufacturing jewellers understand better how to

bring their wares into public notice, and thus to hold before the public their standard of taste, which bad as it is people know no better than to accept.

I would like to explain why the jewellery of commerce cannot possibly be considered as works of art—no matter how elaborate and expensive, and also why the simplest ornament—made even of the less precious metals, and set with the cheapest of stones—may be lovely and satisfying.

If you look over the catalogue of a jeweller's supply shop, you will perceive a very strong reason why trade jewellery is dead as far as any artistic quality is concerned. You will see there rings, pendants, brooches, and so on, ready-made by the thousand, with holes to receive the stones. And all parts of these—pins, clasps, settings—which should enter into and form part of the design, are sold also by the thousand, ready-made. Then, in the factories where these things are turned out, the aim is —not beauty or originality — but the largest return for the money. One man makes only one part, the man who makes each little separate part of a brooch or pendant, cannot make the whole. If he makes clasps—he makes nothing else. If he makes joints, or pins, or settings, or whatever it may be, that one branch is his limit; it is all he can do. It is not his fault that he is narrowed into one groove. It is the fault of the commercial system which inevitably makes profit the first consideration. Then the designs are supplied by men who are not artists, but are supposed to understand trade requirements.

Is it conceivable that a work of art could result from this means? Is it likely that the workman can take the smallest intelligent interest in what he is producing? The other day, in Charing Cross-road, I came across a book labelled "Designs for Jewellery." It looked well used and worn. I thought "Here must be something interesting!" It was evidently a design book of some firm of jewellers. The designs were all nicely and carefully drawn, with a high light on every stone, and each one was, if possible, more stupid than the last. A sapphire surrounded by diamonds, a crescent, a daisy, a star, and so on, through all the glittering list of stupidities. It represented very well the jewellery of most of the shops—all on the same plane, but below mediocrity. A shop in Regent-street is advertising its latest novelty. This is called the Diabolo brooch. I leave the rest to your imagination; no doubt large numbers of it will be sold. A Bond-street shop is exhibiting an electric launch in diamonds, surrounded by a lifebuoy in white enamel with a gold rope. This is an achievement to be ranked with the diamond motor-car, after the dogs and birds and horses and foxes, &c., which have been a stand-by for so long. A few firms, I see, are making violent efforts to be artistic. An advertisement which may be seen in a current magazine is amusing. This caution appears: —"Avoid machine-made jewellery—it lacks originality." This is accompanied by illustrations of objects, which, I presume, aspire to be what they say are:—'Present-day jewels of advanced character.'" They are more or less unshapely blobs of silver, or perhaps gold with stones, or enamel here and there. The jewellery trade having come to this pass, when the maker attempts to avoid the stereotyped article, he blunders into the would-be artistic, and the result is deformity.

Another firm has evidently secured some designs by artists. I am told that the practice is to buy one example of each kind which seems to lend itself to the purpose, send these to Germany, where they are cheaply reproduced, and sent back to be sold by the dozen, or hundred, in competition with the work of their originators. This is by way of showing that the path of the artist is not altogether made smooth; he has difficulties of various kinds to meet. Once knowing what happens, I trust he avoids being exploited a second time.

It is interesting to see that, as far back as 1892, when Mr. Tonks read an able paper here upon the "Artistic Treatment of Jewel and Address Caskets," he deplored the unblushing audacity with which much of the work of that day violated every canon of art, and he looked forward hopefully to the future education of workmen and designers, that they might be able to avoid these infirmities. Fifteen years have passed, but most of the caskets, as well as the jewellery for personal adornment, are made in the same way—design and finished work, both turned out in hot haste under the lash of increasing competition. Generally, these caskets are monuments of misdirected ingenuity, the necessity for haste and show has killed the art. Fancy anyone, now-a-days, spending forty years over a piece of metalwork, as Ghiberti did on the bronze gates of the Baptistery of St John!

Mr. Edward Spencer, Mr. Alexander Fisher, Mr. Nelson Dawson, and Mr. Henry Wilson, each have been responsible of late years for some very beautiful caskets, designed with

thought and art, and executed with skill. But these artists have nothing to do with the system in vogue with the commercial houses. Their work is designed by themselves, and executed in their own workshops under their own eye.

However, it is more of the goldsmiths' and silversmiths' craft as applied to personal jewels that I wish to speak; and especially of what is being done by the small group of workers who may be called the pioneers of the renaissance of English jewellery and silver work, for most of these artists do not confine themselves to jewellery. In most cases they make cups, bowls, caskets, and silver dishes of all kinds as well, and many of them also produce larger work in steel, bronze, and iron. Ten or twelve years ago, very few artists had turned their attention to jewellery. Mrs. Newman was, of course, the first woman to set up a workshop and salesroom of her own, where the work was carried out by her own workmen from her own designs. Mrs. Newman read a paper here, in 1894, upon jewellery and the alloys and colouring of gold; I believe I have the honour to be the next woman to follow her.

The beginning of the present artistic movement, which is being followed by both men and women, was when Mr. Alexander Fisher opened his studio for enamelling and metal work. Mr. and Mrs. Nelson Dawson worked in this studio for a time when it was opened, not as pupils, but as co-workers. In those days, it was very difficult to get instruction in the art of enamelling. Trade enamellers would not impart what they deemed to be their secrets, and, but for the classes which were held for a time at South Kensington, taught by a Frenchman, there was no instruction to be obtained. Mr. Fisher received his knowledge of the technique of enamelling from those classes. Among the first enamellers, too, were Miss Gertrude Smith, now Mrs. Gilbert Bayes, and Miss Nellie Woodward, who now devotes herself to jewellery in general quite as much as to enamelling. Miss Eleanor Hallé also was one of the first workers. To learn the technique of jewellery-making was very difficult at that time, too, for trade jewellers would not teach an outsider, and of other jewellers, there were none. However, Miss Woodward and Miss Smith persevered, and by dint of finding out a little here and a little there, gradually gathered together the knowledge necessary for metal work, and the making of jewellery. Among the very first to see the possibilities of artistic jewellery were Mr. and Mrs. Arthur Gaskin. They began by making simple pieces with their own hands. Their work has developed and elaborated, and is known now wherever modern jewellery is known. They are artists first, and jewellers afterwards. This is the case with all successful artist jewellers. Mr. and Mrs. Gaskin taught themselves, too—this is another excellent road to good work. Many of the successful jewellers have taught themselves, picking up here and there the processes of soldering, and so on. Of course it is beginning in the right way to apply the art to the craft. The technique of every art or craft is exacting, but the technique can in time be mastered if the essentials are there.

The trade has mastered the technique, overmastered it, one might say, and left the essentials out. Mr. Fisher's jewellery is probably known to every one here. He uses *repoussé* with enamel, and little painted enamel plaques monnted in well-designed gold or silver settings, sometimes with jewels.

The work of Mr. and Mrs. Nelson Dawson will be known, too, to everyone interested in modern jewellery. Mr. Dawson designs large work—iron gates, electric light fittings, and many other things, which are carried out by workmen whom he has trained in his own workshops. Mrs. Dawson does the enamels. Whenever she turns out an enamel of particularly happy colour or pattern, her husband designs a setting for it, or she designs the whole jewel herself. Mrs. Dawson tells me that it does not pay very well, as it takes much time and care and money to produce it. They do it really for the love of doing sound and practical work as well as what they consider to be suitable and beautiful. Of course, cheap work cannot be produced in this way, and it is the way in which all artists work.

The chief artistic difficulty all round seems to be to produce good work that will pay, or at least that will provide a living for the workers. There is so much bad and cheap work produced and sold, in competition with the good, and the public often seem to prefer the bad, perhaps because it is cheap, so that there is always before the artist the temptation, and sometimes the necessity, to produce something which will sell quickly.

In 1899, Mr. Montague Fordham opened the Gallery at 9, Maddox-street, in order to bring before the public the best modern handicraft, and encourage a movement which had rather

languished since the death of William Morris. Here, standard was put before everything else —even finance. It was, from the beginning, the only Gallery in London carried on on these lines. Mr. Edward Spencer, Mr. Henry Wilson, Mr. Paul Cooper. Miss May Morris, Mr. Benjamin Nelson, and Mr. W. S. Hadaway were among the first artists to contribute jewellery and metal work, and I think all of them have continued to do so. It has now changed hands, and is known as the "Artificers' Guild." It is run on the same lines, and connected with it are workshops at Oil Mill-lane, Hammersmith, under the direction of Mr. Edward Spencer. To the workshops, visitors are freely welcomed. The managers are anxious for their clients to go and see the orders being executed, so that they may, in some slight degree, understand the limitations imposed by the material, and the principles which underlie the exercise of their skill, principles which, basing themselves upon utility and expediency, permit just this or that degree of efflorescence, and impose this or that degree of restraint. For metals to be tortured into shapes suitable only for some other material, and rendered in naturalistic forms, besides being very unsuitable, offends every rule of taste. Then the extreme finish in fashion with the trade is unpleasant. The makers seem to think by removing all evidences of the workman's touch that much perfection is gained. At the workshops of the Artificers' Guild the designs are derived from the study of the work of the best periods, they are not mechanical reproductions, but object-lessons in the exercise of beautiful methods of construction. The jewellery workshop is managed from the technical side by one who is himself a craftsman and an artist, and the terms upon which all boys and girls enter their employment are that the Guild will do their best to equip them with individual independence as master craftsmen in the future. This is how a dignified art is made of what is usually a commercial business.

Mr. C. R. Ashbee, a few years ago, removed his workshops to Chipping Campden, Gloucestershire. This interesting social experiment has so far been successful, but, even here, commercialism creeps in. When I undertook to write this paper, I asked Mr. Ashbee about certain jewellery which I had recently seen in his Brook-street shop. He replied that, as I said, a good deal of the jewellery was not up to the standard of the earlier work, and the bulk of it was not designed by himself. He said that, in his view, until some proper external standard is set up to check bad workmanship and regulate the shops, it is impossible for good stuff to stand against the competition of the inferior work. This is the rub—the artist has to spend time and care in producing good work, and the ignorant public very likely pass it over for bad and cheap things. There is, however, a class of people of good taste, and they are steadily increasing, who will have nothing to do with shop jewellery, and who know the difference between good jewels and those of inferior workmanship, and it is for these that the artist must work, and among them find his patrons. If people, of education and culture in other matters, understood anything about ornament, or had taste in the decorative arts, they would shudder at wearing the jewels with which they complacently deck themselves. But the decorative arts are sadly misunderstood by the public at present. I have been in many houses since I came to England ten years ago, and very few of them that I can recall are really furnished with good taste, that is—not filled with over-patterned and unsuitable paper and draperies —not overcrowded with everything. It requires much searching in London at present to find furniture for a house that a person of taste in such matters would care to live with. If, however, everything were made beautiful and appropriate, instead of hideous and inappropriate, the pleasure of the hunt would be all gone. If the ordinary articles of daily use were made of good patterns and materials, the chase through out-of-the-way places for possible things would be no more.

Certain people, far too many of them, do receive pleasure from atrocious things. I know a man who has had all the old oak in his house painted white, with red plush panels! But I am not talking of furniture, I am talking of jewellery. I only want to point out that excellent people, perhaps with kind hearts and high places in their professions, or whatever their walk in life may be, think that little matters, like suitable furniture and ornaments, are of no moment.

Those who make a specialty of any branch are apt to over-rank the importance of it in relation to the many other equally important things, but if an art is to be practised at all, surely it is important to practise it to the best effect. Jewellery, of course, ranks among the minor arts, but most people may not realise that to design and execute good jewellery and metal work requires as much

talent in its way as to produce any other work of art. Of course, I am speaking only of the best.

Mr. Harold Stabler is one of the principal artist-jewellers and metal workers. His church metal work is well known, and he has made some good jewellery. I have seen some charming pieces in the style of the Hungarian work to be found in the Budapest Museum—little five or six-petalled flowers among filagree or leaves. He uses gold and silver together most harmoniously. In one of his necklaces the large central pendant is carved in a wreath of silver leaves and blossoms—among these are settings of gold holding various kinds of stones—within this wreath is suspended a little niche in silver ornamented with niello. In the niche stands a virgin and child in gold *repoussé*. The chain is of silver with gold star at intervals, from which depend eight tiny kneeling angels in silver.

To try to describe a piece of jewellery in words is rather futile, because it is upon qualities which elude verbal description that the success rests, such as the proportion of each part to each other part, the distribution of the stones, the relation of the colouring to the shape of it; in fact, the sizes and shapes and colours of every part of it, which only a drawing or a photograph can make plain. I would like to describe some of the jewels of Mr. John Bonner, but I am sure the description could convey no adequate idea of the jewel itself. Some of us will have seen the shrine of the Holy Grail pendant, or the Tristan and Iseult necklace, or some other of his masterpieces of symbolic jewellery. These jewels, designed and wrought with exquisite skill, are among the most lovely of modern work.

Mr. Henry Wilson, whose practical handbook on jewellery appeared a few years ago, stands at the very head of this movement. Nothing better than his thoughtful and well-made jewellery has been done.

Mr. Paul Cooper and Mr. Bernard Cuzner are both well-known artist jewellers. Time does not allow me to name all those who are working in the right direction. These are a few of the pioneers whose work is best known. A few of the chief women jewellers are Mrs. Traquhair, who is mural painter and embroideress as well, Mrs. Mills, Mrs. Eastlake, Miss Ethel Virtue, Miss Awdry, and Miss Steer of Birmingham, Miss Agnew, Mrs. Roscoe Mullins, Miss Goff, Miss Violet Ramsay, Miss Woodward, and Mrs. Gilbert Bayes. Mrs. Partridge is an accomplished enameller, while her husband is a jeweller and worker in horn. There are many others, and the numbers are steadily increasing since the opening of the classes for jewellery at the Sir John Cass Institute, and the Central School of Arts and Crafts, though the latter is only open to those who are apprenticed to the trade. As the supply increases, let us hope that public taste will improve also; more people appreciate good jewellery now than nine or ten years ago. The trouble is that so many do not know the difference between the really good and the would-be good.

Frequently, when this new movement is referred to, it is confounded with that curious phase known as "Art Nouveau." Now nothing could be further removed from the remotest resemblance to "Art Nouveau" than the direct and simple methods of these workers. "Art Nouveau" never received much encouragement in England—meaningless wriggles and worn women with streaming hair, pendants and clasps which resemble nothing on earth but the pelvic bones of a skeleton somewhat deformed. Then there is the pansy done in horn, true to life in form and colour—probably a half-faded pansy with tired petals. We realize that all this is not art.

The skilful work of the two Frenchmen who exhibit in London, M. Lalique and M. Galliard, cannot be classed with "Art Nouveau," however. One must admire their workmanship; they have a subtle sense of colour, and a fine choice of materials, but they are so absorbed in the prettiness of things, or in their desire to be new or eccentric, that they lose sight of the essential.

I came across a photograph of a jewel by Mons. Galliard not long ago. It appeared to be a compromise between a beetle, a skeleton, and a woman, that is, some of the characteristics of each were introduced into the design, with most unhappy results. Even the skill of the workmanship, the beauty of the material, or the fineness of colour cannot reconcile one to these eccentricities. A beautiful design always has the virtue of repose—the restless and uneasy groping for novelty cannot lead to beautiful and satisfying results.

In old work, great variety of results were obtained by simple means. In new work, with every kind of complicated means, the results are often monotonous. It is from the old that those who are doing good work to-day receive their inspiration, not by repeating the forms or combinations of forms that were

once the deliberate expressions of minds in harmony with the spirit of their age but by understanding what has been done in the past. Through this knowledge and by obedience to the laws which time has established by simplicity of method to obtain variety of results, and by avoiding those mechanical appliances in the use of which jewellery arrives at such a dead level of commonplace, that workers are enabled to produce fresh work of sound execution. There are certain appliances which, of course, it is permissible to use. For instance, if it is desired to repeat a number of small units, such as little five or six-petalled flowers like we see in old Hungarian work, or a number of little leaves or devices of any kind, it saves time to have a die cut in steel, and with this to stamp them from the sheet upon the lead-block, and, as repetition is a very valuable factor in design, this saves the laborious process of cutting each leaf by hand from the sheet. The cutting of the die is most important, for as a rule the professional engraver will give you a cut and dried representation of what you want.

The modern jewellers are so individual that anyone who is familiar with them can pick out at a glance the work of each, and of the pupils influenced by them. Yet, as Mr. Voysey says, we are apt to over-estimate the value of so-called originality, without distinguishing between the healthy form of it, and that which is mere eccentricity. I do not mean for a moment to say, that all those who make jewellery by hand, or work independently of trade firms, are the authors of good work. There are plenty of misguided ladies who, without training in either design or craft, make so-called ornaments, which they sell to their friends and the uneducated public. Slabs of silver, spread with turquoise blue enamel, or green for variety, with a pearl blister affixed here and there; I have often seen it done with gum or seccotine. This has nothing to do with the art of the jeweller. It ranks with the jewellery of the Rue de Rivoli and the Palais Royal. To wear these ornaments calls for high courage, which is apparently not wanting, and brave souls deck themselves with it heedless of the fact that it is gaudy and deceitful.

Enamel, of course, has its beautiful uses, and in little pieces used with jewels, or little bits of delicate *cloisonné* made with a thin wire (this is very little done, and it is one of the loveliest ways of all to use enamel for jewellery), it is very appropriate.

Little painted enamels, or *champlévé*, are beautiful. They may also be used to enrich elaborate pieces as in the fifteenth century Italian work. All these ways are fitting and appropriate, but unbridled indulgence in large surfaces of bright translucent colours is not to be commended. Instead of a restrained mastery over the material, this is a debauch.

The great goldsmiths of the Renaissance were sometimes very sparing in their use of colour, subordinating it to the more precious jewels. Simple schemes are often very satisfactory, such as blues and greens on white, white, turquoise and green upon cobalt.

Mr. Lewis Day, in his recently published book upon enamel, says, "It seems to be thought that because bright colour is to be got in enamel, the brighter the better, and the more of it the more beautiful." I think that little jewel-like pieces of enamel are quite permissible, either in *cloisonné* or *champlévé*, but not a great slab of it. As the quality of transparent enamel is clearness and brightness, it cannot be right not to use the material at its best; that quality should be made the most of, but with discretion. I do not believe in jewels made with enamel on standard silver; the result is mud. For all good results in enamel, fine silver, or fine gold is necessary.

There are a number of women who make really good jewellery, and a number who just fall short of doing good work. As far as the intention, the design, and the artistic quality go, all is well, but their hand has not served the apprenticeship long enough to make them mistresses of their implements. Untidy work can never be good. It is not, as some suppose, an artistic quality in a jewel to be sloppy and ill-made. It is in spite of, and not because of this, that many of these jewels are successful. If one can design and originate good jewellery, it is better to employ a competent workman to carry out the scheme under one's own eye than to spoil it with amateur workmanship. To be master of the blowpipe and chasing hammer takes a long time and much practice.

A short time ago I visited the galleries of the Fine Art Society. After seeing there some excellent jewellery by Mr. and Mrs. Gaskin, rich with little flowers and leaves of enamel, among which were set jewels of various colours, and the vigorous and sincere jewellery of Mr. Hodel, I came to another room where there was a large case of jewellery by M. Galliard. The workmanship was more than skilful, the colours were delicate, the materials were good, but after the restrained and simple

work of Mr. Hodel and Mr. and Mrs. Gaskin, where the design was nicely adapted to the limitations of the material, it came upon one as a shock—an orgy of delicate realism. There was a daisy made of Baroque pearls, which Nature had shaped very like the petals of that flower. There were combs and pendants and various objects copying exactly in both form and colour leaves and flowers and insects. If this were all there would be no room for Art. Anyone can be trained to make a copy of a flower or insect, or pretty much any object in Nature; but Nature is not Art. It is only when Nature is translated by the artist that it becomes Art, not when it is slavishly copied. One would have supposed that this was so well known that there would be no need to say it; but apparently not. I have heard otherwise intelligent people maintain that the more exactly a thing was copied from Nature, the better Art it was. It is only the individuality of the artist that makes the Art worth anything, and if twenty artists were to make a literal copy of, say, a lizard, and if all made it exactly like the model, it would be more a mechanical accomplishment than a work of Art; moreover, the same result could be arrived at by casting. For horn and metals to be made to imitate flowers is all wrong. If an image of a flower is to be presented, it must be an image upon which the limitations of the material have been imposed; for no matter how literal an imitation may be, it can in no way compete with the flower as Nature presents it.

In ornament, therefore, it is necessary to make use of a severer treatment. In the examples which have come down to us from the earliest times to the present, in no instance has the practice of introducing facsimiles of natural forms been tolerated.

The use of symbols, or a meaning in a jewel, might, I think, easily be carried too far. In the Middle Ages, in the reign of Francis I., devices, as they were called, became so fashionable that almost every personal ornament was made to express a sentiment or meaning of some kind. Sometimes these high-flown and ornate conceits were so elaborate and far-fetched that, instead of conveying a sentiment, they became very puzzling enigmas. In symbolic jewellery now, I think the mistake might be made of paying more attention to the symbols than to the results as a whole. It is by no means necessary or even desirable that a literary quality should be attached to a necklace or pendant, or ornament of any kind. If in certain instances, a sentiment or symbol can be expressed without interfering with what might be called the rhythm of the jewel, no harm is done, but it is quite enough that the jewel should be of good form, good colour, well designed, and well-made throughout.

Perhaps I should apologise for expressing this opinion here, because the view is opposed to that of Sir George Birdwood, who is in his very able and well-known works on the industrial arts of India, considers jewellery other than symbolical, to have no *raison d'être*, and to be unmeaning as mere ornament.

Speaking of symbolic jewellery, reminds me of a lady, who came to me one day and said she wanted a symbolic jewel. I asked her what she wanted it to symbolize. She didn't know, or care, but she liked interlaced triangles, a serpent or two, and some Zodiac signs. Even painters seem to think that it improves their picture to add a verse of a poem to it. Now, if the picture is satisfactory, it does not need the literary prop. If the picture is weak, the literary prop cannot strengthen it.

I would like to say a word or two about materials. Silver is generally more satisfactory than gold. The yellow of the gold is often too strong for the stones, and it is extremely likely to be too strong for the costume or the complexion of the wearer. Even copper can sometimes be used—it all depends upon the gown and the occasion. Suitability for the occasion is a very important consideration. To be properly equipped every woman needs a variety of jewels, for what suits one gown and occasion is most undesirable for another.

Not along ago I saw a necklace—I forget where it was made—but somewhere where the people are primitive. It was really beautiful in simple design and colour. It covered the lady who wore it from neck to waist. The effect with a modern tailor-made gown was most incongruous. It was evidently made for a climate where necklaces are more popular than tailor-made gowns, and there would have been most suitable and lovely. It is in providing ornaments appropriate to all ordinary occasions that the hosts of semi-precious stones are so useful. At moderate cost, as jewels go, one may have a variety of pendants, brooches, necklaces, &c. The range of colours is wide—the green of the chrysophrase, the blue of the turquoise, the purples and mauves of the amethyst and amethyst quartz, the white and grey and yellow of pearl blisters, the green and pink of the tourmaline, and the shades between them—one end of the tourma-

line crystal being pink and one green—the grey-blue of the blue chalcedony, the delicate pink of the rose quartz, the silvery grey of the moonstone, the mottled orange of the sunstone, the opal-like haliotus shell, the various jacynths and hyacinths and zircons, the yellows of the topaz, the dull red cornelian, the clear rock crystal, the curious grey and blue shot labradorite, corals, lapis lazuli, the innumerable shades and varieties of Mexican opal, and the matrix of this, and, most beautiful of all, the opal and opal matrix—this bewilderingly lovely stone, made of tiny specks of every colour, juxtaposed in such a changing variety that a counterfeit is not possible. The diamond may be counterfeited, but not the opal; it defies imitation. There is an unfortunate and quite unfounded prejudice against this stone. Sir Walter Scott was largely responsible for this in his novel, "Anne of Geierstein," though another superstition dates back to the seventeenth century, when, at the time of the plague in Venice, an observant person noticed on one of the victims an opal which grew milky and lost its brilliancy. So far was the opal from being considered unlucky in the Middle Ages, that it was believed to possess the united virtues of every gem whose colours were to be found in it. And all sorts of virtues were then ascribed to precious stones. The pharmacopœia of the Middle Ages contained many a sovereign remedy made of powdered gems, and to every gem was ascribed a virtue. The diamond alone was considered poisonous if administered in powder.

There is much difference of opinion about the diamond now; some artists refuse to make use of it at all. I can see no reason why the diamond, used properly, should not be beautiful, particularly with coloured stones. As it is now worn, it is simply an outward and visible sign of the wearer's wealth, or least of credit with the jeweller. There is a sort of reason, too, for these glittering masses. At large functions, the opera, large receptions, and so on, but for plenty of glittering stones, the jewellery worn would not be noticeable at all. If much glitter is the desired aim the more quiet jewels of beautiful design would not answer; but after all limelight and spangles supply more glitter than all the diamonds put together, so, as it is impossible to vie with sham glitter, surely more quiet jewels which depend upon the art of their making for their charm are more desirable.

Of course, everyone has his own method of working. I do not think that from designs first drawn on paper, and then carried out by the workman, that the best result can be arrived at. The more spontaneous way is to have at hand the grains, the wires, the twist wires, and bead wires of various sizes, various little devices made with these and with the stones and materials to arrange the pattern as one goes along, handing it to the workman to be soldered and finished, or after having made the pattern in this way, to make the sketch, and hand this with the pieces to the workman, unless it is all to be done with one's own hands, and time hardly allows for this if one has to design and make everything. To people who work in this way, it is disconcerting to be asked for designs, for as the stones, or pieces of enamel, or devices at hand suggest the designs, it is working backward to make the drawing first.

There is not much literature of artistic jewellery in English. I should like to recommend Mr. Wilson's book, Mr. Nelson Dawson's (recently published), also Mrs. Nelson Dawson's book on enamelling, Mr. Day's recently published book on the same subject, which deals with it from the historical, while the Chairman (Mr. Henry Cunynghame's) deals with it from the technical side. This book has been of the greatest service to those who wish to understand the processes of enamelling; many people have learned the art from it alone. Then there is Mr. Cyril Davenport's small book on jewellery in the same series as Mrs. Nelson Dawson's on enamels. Mr. Fisher has also written a short account of enamelling, more theoretic than practical. No better treatise on the art of jewellery has been written than the one which the monk, Theophilus, who lived in the eleventh century, has left behind him. These old monks worked under ideal conditions, without haste, and without worldly cares. But for them, the arts would have fared badly in times when countries were turbulent with wars, and outside the monasteries there was too little tranquility for their practice. All the books in the world on the subject are not as much use as a little actual practice—a good deal of actual practice perhaps I should say.

Some make the mistake of thinking that the more elaborate the design the better it is. Now the simplest arrangement may be infinitely better than the most elaborate. It all depends upon the result, and the over-elaborate is more likely to be wrong somewhere. Sometimes, indeed, what would be quite good and

satisfactory is spoiled by over-elaboration. Well-wrought simplicity is admirable; for instance, the Italian peasant jewellery. It is not necessary for all the little fishes to try to look like whales. Without a proper sense of fitness and a feeling for good design, no jeweller can produce good work. A fine sense of discrimination is necessary, so that among the many historic styles, and the hybrids of these, one may not come to grief. There are just as many *bad* old styles as there are good —rather more, perhaps—and blindly to copy an old style because it has survived is not likely to lead to good results. Some of the very best and most sincere and simple of the old work has been lost, for, unlike a picture or statue, the precious metals could be melted into ingots of value, and the jewels removed and sold. Every piece of work by the famous artisan bishop of the seventh century, St. Eloi, has been lost. This patron saint of jewellers executed many important works for churches under the patronage of Dagobert I., among them the shrine of St. Geneviève and St. Germain; also jewels for personal use. His own garments were thickly embroidered with gold and gems. He wore a golden girdle set with precious stones, his gowns were of fine linen embroidered with gold, and the border of his silken sagum was likewise adorned. This was at a time when, of course, all the courtiers of the Frankish King were clothed in the richest manner. They were passionately fond of costly dresses and jewels and even jewelled weapons. Scarcely any examples of the goldsmiths' work of the first centuries of the Middle Ages remain. This would, if we had it, be a rich source of inspiration for the artist.

It is entirely a modern mistake to separate the art of the jeweller from other arts. At the end of the fourteenth century, two great artists came from the workshop of a goldsmith, Fillippo Brunelleschi, and Luca della Robbia. Ghiberti never renounced his original profession, but continued during his whole life to execute works connected with the goldsmiths' art.

Benvenuto Cellini, who stands at the very head of the goldsmiths of his time, and who brought the art of chasing to a greater perfection than had been known before, was as well as goldsmith—sculptor, artist, author, and, according to his own tale, warrior and braggart as well.

Verocchio, whose statue of Bartolomeo Coleoni at Venice is said to be the finest equestrian statue in the world, was first a goldsmith; Ghirlandajo, and Francesco Francia—in fact, all the goldsmiths of this wonderful period, the fifteenth century—were also either painters or sculptors, or both.

The art of the goldsmith was considered to be a fine art; now it is a trade, and while the public who buy are contented with the products turned out by the trade, the artists will have to be satisfied with less commercial success perhaps than falls to share of the more unworthy product. About 20 years ago, a commercial house made an effort to elevate the public taste in jewellery. They employed some of the best known artists of the time, and spent considerable sums on it, but the result was a dead failure, and they were obliged to fall back upon the old lines as regulated by the law of supply and demand. I have no means of knowing what the result of these experiments were, but it would seem that when commercialism comes in at the door, art flies out at the window. The Guild system has been suggested as a remedy: that each person working at jewellery or any other craft should be examined by masters, and granted a certificate before they might practise it, but this would not prevent commercial houses springing up outside the Guild, and competing with it.

I am sure it must be impossible to try to apply to one age the conditions which fitted another. We have to cope with present conditions. It is not possible now to hold together a Guild, which could exclude from practise all but the capable. The Guild, except as a species of aristocracy of craftsmen, is a thing of the past.

DISCUSSION.

The CHAIRMAN (Mr. H. H. Cunynghame) thought the paper was excellent, and free from many of the fancies which had deformed some of the art teaching of the present time. He desired, however, to offer one or two criticisms on some of the points raised. In the first place, he thought it ought to be at once recognised that stamped jewellery was not necessarily bad. The whole of Birmingham depended upon stamped jewellery, and would do so as long as people would buy it, whether artists liked it or not. The first point it was necessary to determine in their minds was whether stamped jewellery, as a whole, should be condemned. At first sight one would be inclined to say, perhaps, that it must be bad. Some gold, more or less alloyed, was stamped out by good machinery, with steel dies, at the rate of an article a second; a little backing was

soldered on to it, and it was then sold as a locket. If it was taken as an axiom that stamped art was bad, what was to be said about Greek coins? They were not bad, and yet they were stamped from a die. There was no more beautiful stamped work in the whole of the British Museum than the collection of stamped designs which Disraeli bought, on his own authority, for the nation. Nothing more exquisite could be conceived than the female faces on some of the coins. There was another branch of stamped art which was extremely beautiful, namely, the early Georgian plate. The square candlesticks of that period were nearly all stamped in exactly the same way as they were stamped at Elkington's at the present day—with a weight and a heavy die. It would, therefore, never do to condemn the whole of stamped art. It was necessary to remember that many women could only afford a little piece of stamped jewellery. Therefore, if Birmingham was encouraged to turn out good designs, a legitimate want was supplied. It was interesting to inquire what were the causes of bad art. In the first place, it must be borne in mind that the reason ladies wore jewellery now was somewhat different from the reasons which actuated them a good many years ago. He was aware that women had never changed — they never would change. But in olden days ornaments were purchased for rather a different reason than they were at present. There were three causes at work which induced women to wear ornaments. In the first place there was a religious motive. At the present time religious ornaments had almost entirely gone out of fashion, but in olden days people wore religious ornaments with a really pious feeling. Then they wore them for good luck. There could be no doubt that right up to the sixteenth century people wore images about them which were supposed to confer immunity from accident and danger. In Roman and Greek times there was a very strong reason for wearing jewels, namely, that they were considered to have an effect upon the health. In Pliny's letters there was an exceedingly long description of jewellery; and, by the way, it was astounding how much modern science had been anticipated by those Letters. Anybody who observed a diamond properly knew that its beauty consisted in its smallness. If a tiara of diamonds on the head of a pretty woman was carefully examined, it would be found that its beauty consisted in the flash of the lights upon the stones. If a lady was giving a dance, and desired to make all the ladies' diamonds look nice, she must have single electric lights fitted up, without any dull glass in front of them, and beautiful scintillation would then be obtained over the heads of the guests, just like a ripple of light. But a great thing like the hideous Koh-i-noor or the Cullinan diamond was like a common bit of white glass, with no interest in it whatever. There was another great drawback to good art, namely, art theories, which had done more injury to English art and painting than almost anything else. There were people who went mad on theories; they said, "You must have art for art's sake." Mrs. Hadaway herself was on the verge of that heresy, when she said that she thought a literary prop to a picture was a mistake. Why, that was the foundation of the pictures of the world. Art was a language which might deal with anything. He once heard a gentleman, who was a very good artist in his way, maintain that the only hope for English art to-day, was to procure from India a number of native Indian jewellers, to sit down on a little mat, with a tiny blow-pipe and a bit of charcoal, who, if they were given two rupees, made a bit of jewellery. The art of Louis XIV. and XV. was to be given up, Byzantine art was to perish, apparently the Greeks were not to be in it, and the artists of the present day were to follow the little man from India. Why was his little bit of jewellery good? Because he was making a pattern that he had followed from his father's time, and if one tried to get him to do anything else it was impossible. The purchaser must be educated first and then he would take care of the artists. Ladies could not do better than set to work and form guilds for the encouragement of true art, hold exhibitions, and get their friends to purchase the things shown. It seemed to him that in the education of the public the greatest hope for the future art of the country reposed.

Mr. Hugh Stannus, after expressing his appreciation of Mrs. Hadaway's paper, said that he was much obliged to the Chairman for clearing the way to some extent by saying that all stamped ornament was not necessarily bad. He had heard, *ad nauseam*, the manner in which people found fault with everything which was mechanically reproduced, forgetting that there might be just as much art in the design to suit the limitations of the methods, and to make the most of them, as there might be in the amateur work which was sometimes seen. The Chairman had also said that cheap art was not necessarily bad, which was particularly the case in the beautiful jewellery which the Italian peasants wore. It would have been very delightful if some diagrams had been given by Mrs. Hadaway, showing some of the ways in which various jewellery might be collated or composed, whether for the decoration of a woman's neck, or the wrist, or an armlet, or any other purpose for which jewellery was used. He had often felt the drawback to the use of precious metals and jewels by art workers. If an art worker worked in clay it cost him almost nothing; he could make a beautiful terra-cotta statuette without laying out much initial capital in obtaining the material for his art. But when he designed in silver or gold, there was a certain value in the materials which were being worked, and a certain amount of capital was required before any art whatever could be put into it; and that was still more the case when jewels were used. It was a great drawback to art workers that they must spend £20, £30, or £40 in setting up before they could obtain any sort of return for their art

work. There was at the present time a feverish desire for what was termed novelty, and Mrs. Hadaway had very properly condemned eccentricity while approving of real novelty. He ventured to disagree with her, however, in her remarks on symbols. He condemned, not the carrying of symbols too far, but the using of them in a clumsy manner. The more of meaning that could be introduced into life, and in so choice an object as a piece of jewellery, the more permanently interesting it would always be.

Miss Rowe, after expressing her great interest in Mrs. Hadaway's valuable paper, said the author had made no comment upon ancient jewellery. She had regretted that so little jewellery had come down from mediæval times, but there were in existence priceless treasures from the ancient world which all jewellers would do well to study. Some of the very best goldsmith's work in existence was undoubtedly the Egyptian and Etruscan jewellery. She feared it was in the want of the knowledge of the fitness of things that the public showed their lamentable want of taste and she therefore thought it was necessary that the cultured craftsmen should set a high standard of artistic design.

Mrs. Hadaway, in reply, said she did not mean to say in the paper that all stamped jewellery was wrong. The trouble was that such jewellery was nearly always made with the wrong pattern to begin with. If stamped jewellery was made like the Greek coins were made, with beautiful designs, there would be nothing to find fault with. The Chairman had referred to lights being erected so that the diamonds in the ladies' heads would look well. She desired to ask Mr. Cunynghame whether he thought it was more important that the diamonds should look well than the ladies? She was afraid the Chairman had misunderstood her remarks about pictures. She did not complain about artists painting subject-pictures. What she complained of was that the artists, after they had painted their pictures, looked round for verses to tack on to them. A book had actually been published containing titles for pictures, verses and poems, and so on. Surely an artist ought not to have to hunt through a book to find an appropriate title to stick on his picture after it was painted. The Chairman had also suggested that guilds of women should be formed to elevate the public taste. The Women's Guild of Arts had just been formed for that purpose. She had mentioned in her paper the names of several ladies who made good jewellery, and she desired to add the name of Miss Rimington, who was present at the meeting, to that list, as she made very good jewellery. The reason she did not refer at greater length to old jewellery was because Mr. Giuliano had read a paper before the Society and she, herself, had just read one before the Junior Art Workers' Guild on the historical side of the subject. She had said in the paper that none of the jewellery in the early Middle Ages had survived, still there was plenty of ancient jewellery, but the reason she did not mention it was because that fact had already been referred to in pevious papers, and she desired to confine her paper more to the jewellery of the present time.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mrs. Hadaway for her interesting and instructive paper.

NINTH ORDINARY MEETING.

Wednesday, February 5th, 1908; The Hon. Charles Stewart Rolls in the chair.

The following candidates were proposed for election as members of the Society:—

Allison, John William, R.B.A., Havelock-villa, Outram-road, Portsmouth.
Carey, John G., Council-house, Hounslow.
Davis, Alfred A., A.M.I.E.E., corner of Kapteyn and Banket-streets, Hospital-hill, Johannesburg, Transvaal, South Africa.
Duncombe, H. F., the Bournemouth Hydropathic, Bournemouth, and Constitutional Club, Northumberland-avenue, W.C.
Empain, Baron Edouard, 33, Rue du Congrès, Brussels, Belgium.
Gordon, John William, 11, King's-bench-walk, Temple, E.C.
Henry, Dr. Thomas Anderson, The Scientific and Technical Department, Imperial Institute, S.W.
Keith, Mrs. Margaret S., 26, Norham-road, Oxford.
Leigh, Evan Arthur, 33, Brazennose-street, Manchester, and 232, Sumner-street, Boston, Mass., U.S.A.
Merritt, H. Sydney, 13, Hans-place, S.W.
Pennington, Arthur Reginald, The Court-house, Axim, Gold Coast Colony, West Africa, and Kilty Crag, Grasmere, Westmoreland.

The following candidates were balloted for and duly elected members of the Society:—

Baker, Sir Augustine FitzGerald, M.A., 56, Merrion-square, Dublin.
Brown, Edward O. Forster, Springfort, Stoke Bishop, Bristol.
Brown, John Hewlett, White-house, Whiteley-wood Green, near Sheffield.
Carmichael, John, 10, Cortayne-road, S.W.
Casey, Ernest, Thatched-house Club, 86, St. James's-street, S.W.
Garnett, William James, British Legation, Peking, China, and Quernmore Park, Caton, Lancashire.
Knowles, William, Treacher's-buildings, Bombay, India.

Porter, Robert, 37, Chalmers-street, Edinburgh.

Rogers, William David, F.C.S., 36, Grange-road, Smethwick, Staffs.

Singal, Thakur Shiam Sarup, M.R.A.S., Rais, Dibai, O. R. Railway, U.P., India.

The CHAIRMAN (The Hon. Charles Stewart Rolls) in introducing the reader of the paper, said that the subject of aerial navigation was daily attracting more attention and interest on the part of all sections of the community; but the particular subject of war balloons was one of very great national importance at the present time. A few years ago it was decided by the International Convention that the discharging of explosives of any kind from balloons or airships should be barred in all civilised warfare, in the same way that chain shot, expansive bullets, and such like ammunition were. The measure, however, was only a tentative one, and lasted for a period of five years, which expired last year, when the question again came up for discussion at the Convention. On that occasion, although Great Britain was in favour of leaving matters as they were, France and Germany, which had been spending large sums of money on airships, were very much against the prohibition remaining in force, with the result that the Powers were now free to add this new terror to modern warfare. There could be little doubt that, in the next European war, the method would be adopted. France and Germany were fast constructing a fleet of aerial warships, and it was, therefore, a matter of great importance that this country should not be left behind. The Society was fortunate in having a paper read before it on the subject by a practical gentleman who had had a somewhat unique experience in aerial navigation and balloon work generally. Mr. Gaudron served his apprenticeship at one of the first balloon manufacturers of the world, the firm of Lachambre, of Paris, when he assisted in the building of balloons of all kinds for a number of Governments, including the Russian, Belgian, Roumanian and Chinese Governments. Though a Frenchman, the author had spent the past 18 years in this country, and during that time had done much useful work in the cause of aeronautics, not the least important of which was the construction of the Barton airship. The principal fault of that aerial vessel was that she was before her time, and only missed being a success by the fact that it was impossible at that time to obtain a motor of sufficient lightness and power for the purpose. The author's latest achievement was a voyage in the record balloon, "The Mammoth," a balloon of his own construction, which he piloted last autumn from the Crystal Palace to Bracken, in Sweden, in nineteen hours, a distance of 703 miles, no less than 360 miles of which was a continuous sea trip.

The paper read was—

WAR BALLOONS.

By AUGUSTE E. GAUDRON.

I have been asked, as a practical aeronaut, to read this evening a paper on war balloons and airships, and I will endeavour to express a few ideas on this subject clearly, but I am sure you will overlook a few errors due to the fact that English is not my native language. It is obvious that the subject we are to consider largely belongs to the scientist and the engineer, but it will be admitted that a practical man, without being either an engineer or a mathematician, may have something to say about it, and I think I can claim to have experience. For the past twenty-eight years I have earned my livelihood as an aeronaut. I have made balloon ascents in most of the principal Continental and English cities. I have made thousands of ascents under all conditions, and I have descended by parachute on the sea, the land, and into trees and upon houses. I have also been up in a kite. I would like to say here and now that I do not see many impossibilities in ballooning. It may be said that ordinary ballooning has not advanced much for a hundred years. But nevertheless I regard it as a safe means of making extensive voyages and researches, and even as a practical and utilitarian thing quite apart from pleasure-making. So far from the ordinary balloon being superseded I claim that there are vast possibilities before it. I have constructed hundreds of balloons of all kinds, some were for inventors whose ideas were more or less good. I have made and ascended in three large airships, two of my own pattern, the other the Barton airship, which you doubtless remember.

The conquest of the air is a very big subject. It is one of the leading newspaper topics, but in spite of all this publicity, it is painfully evident that very few people know anything about it. Experts spring up every day. Patents are taken out for new motors and new propellers, and journeys of 50, 70, and 200 miles an hour are spoken of in the newspapers, and it certainly sounds very wonderful to the general public. And out of all confusion one thing to my mind stands clear, and that is, there remains nothing more to invent. It only belongs to the practical engineer and practical aeronaut between them to make something to rise in the air, and to ascend in it. I say that practically nothing remains to be invented. Let us consider. The principal airships of

the day are, the "Santos Dumont," the "Lebaudy," the "Deutsch," &c. Now, what patents have been taken out for these? Not one. And you may remember that when the French airship, "La Patrie," was blown away, and touched land in Ireland, the French authorities declared that they did not mind anybody seeing it. Nobody could learn the secret. There was some talk in the newspapers about keeping the public away, but the French Government expressed itself very clearly in the matter. And why? Because the only secret lay in the practical work they had done, in their knowledge of how to use it. Is this not also clear from the fact that when "La Patrie" was lost it was in the charge of soldiers, and its designers and constructors were far away. Indeed, there was nothing secret about its construction or working. I will presently explain why I think that airships of this kind—improved, of course—are the airships which will do practical work in warfare, possibly in our own time. First of all, however, it is necessary to glance at other types. We have in aeronautics the two principles, the heavier than air, and the lighter than air. The heavier than air is the machine without a gas-bag that rises and manœuvres by mechanical power, propellers, and wings. The lighter than air vessel is one that is lifted by its gas. This is either the ordinary balloon, which drifts with the wind or is held captive by a rope, or it is the balloon propelled through the air by means of a propeller.

Without going into details of bird flight, and the impossibility that human beings will ever be able to do what birds do, I wish to point out that the experiments now being made with the heavier than air machine—the aeroplane, are more to be compared with an athlete practising to make a record in some feat. We are dealing to-night with air warships, and I claim that, for the moment, the air warship of practical politics is the dirigible balloon. Personally, I think the heavier than air principle doomed to failure, for essential reasons, and while the prizes now offered for flying kilometres and other achievements will probably be won, the winning of these prizes will be quite sufficient. Because one man can fly with an aeroplane a certain distance, it does not follow that he can teach others to do the same. The extreme inutility of these machines must be apparent to you. They do not ascend more than a few feet, but to travel ten miles in the air at the rate of 20 miles an hour it would be necessary to rise from 100 to 300 feet in order to clear obstacles. Certainly all existing motors are utterly inadequate, and when the motor stops there is disaster. It is very difficult to get one of these motors to work for more than a few minutes. A petrol motor may stop for want of proper mixture, and when you are constantly changing your altitude it is almost impossible to obtain the proper mixture. Here is an example of what I mean, in the wording of an advertisement of the manufacturers of the lightest motors:—

"To gain the 50,000 francs, the Grand Prize of aviation, buy an Antoinette motor and propeller, attach to it an arrangement of canvas and steering wheel, sit tight on it and screw up your nerves, and you may win the prize."

But with regard to the experiments with aeroplanes, is it not a very eloquent commentary on the situation that the French Government is not spending any money on them at all. It is not discouraging experimenters, but as regards itself it is devoting its money to the founding of a fleet of dirigibles. Long ago, however, the French Government did spend money on aeroplane experiments.

To come to the lighter than air principle, and it is this which is now engaging the attention of the various ministers of war. The balloons for war can be classed under three heads:—The captive balloon, the free balloon, and the dirigible balloon.

The captive balloon has been in use by various Powers for a long time, and it has been practically developed to its limit. The balloons may differ in shape and in the materials of which they are constructed. The captive balloon is used to discover the strength and disposition of the enemy on land or sea.

The free balloon has a much larger field of action, and it certainly has not been fully developed. As to the possibilities of the ordinary balloon, perhaps I may refer to my recent voyage from London to Sweden, the longest oversea journey ever done by balloon, and also the longest balloon voyage from England. I can assure you that I hope this is only the beginning, and that I may be allowed to do some bigger aeronautic work in the future.

Great things will be done in peace and war, with war balloons. For example, it would not be difficult to send up one hundred balloons in one day, from London to the Continent, carrying a total of 5,000 men. The cost of such undertaking would not be great, say about £60,000. You ask, what would be the good

of sending 5,000 men to the Continent? But I merely mention this as an example. I point out what could be done. The 5,000 men could be reduced to 300, say 100 aeronauts, one to each balloon—and 200 officers—two to each balloon—and the remaining lifting power could be taken up with ammunition.

Certainly three or four balloon manufacturers could manufacture the 100 balloons in three months. There is ample coal-gas in London to fill all these balloons in one day, and the only difficulty would be to find 100 practical aeronauts to take charge of the aerostats and make the best use of them. But, again, see what was done during the siege of Paris in 1870 and 1871. Sixty-five balloons were constructed and out of the 65 aeronauts only about five had been up before. Some of the ascents took place at night, and only two aeronauts were lost and five made prisoners by the Germans.

The 65 balloons carried 164 passengers, some 25,000 lbs. of postal material, representing about 2,500,000 letters; 381 carrier pigeons were also taken up, and did good service by carrying nearly 100,000 messages and telegrams. The receipts from letters and telegrams were nearly £40,000, and the expenditure for the manufacturing of 65 new balloons and the pay of the aeronauts amounted to about £11,700, including the necessary gas, so that you will see there was a margin of £28,300 of profit.

I am putting these facts before you simply to show that balloons are not merely an expensive hobby, but that good use can be made of them at times. With regard to the distance a balloon may travel, I may here say that in our journey to Sweden we had one ton of ballast, and only used about 30 lbs., and we travelled 703 miles in 19 hours. I leave it to you to work out what it would have cost to carry one ton of goods and three passengers from London to Brackan, in Sweden, in 19 hours.

And now what is the present position and future prospects of the dirigible balloon? A certain German Professor once declared that no balloon could ever be made whose fabric and framework could withstand a wind of 20 miles an hour. This reminds me of a story, I was told, of a great mathematician, Professor Tait, who demonstrated that it was scientifically impossible for a man to drive a golf ball more than 180 yards. The very next morning, Professor Tait's son drove a golf ball 220 yards. And with regard to the very crushing theory of the Professor, I would remark that no balloon has ever collapsed purely through the force of the air—while in the air. As a matter of fact, it is simply a question of keeping your gas-bag well filled, and properly made and attached. Some day it will be a question of making the gas-bag stronger than existing bags.

With a dirigible balloon, it is possible to take up a motor that will work well, and also to carry fuel for the motor. The nearest problem to that presented by the dirigible balloon is that solved by the familiar barge, but instead of tons, the airship can only carry pounds. That is the difficulty, and it is only in recent years that progress has been made in solving it.

If you want to steer a balloon through the air you must modify its form to give less resistance in passing through the air you must reduce friction to a minimum, you must find a strong, light envelope capable of retaining the hydrogen gas for a certain time, you must do away with all superfluous netting, and you must procure a reliable and powerful motor, a propeller or propellers, and a rudder. Above all, you must put good workmanship into it and get plenty of practice with it. Before you master your airship you must first be its slave, and your labour is bound to be rewarded if you persevere, but you cannot become an expert without hard work.

On the Continent great progress has been made. The Lebaudy airship is certainly the best ever produced. It has probably done more than 300 voyages. I mean by a voyage to get out from its station and return to it after having made a journey of 10 to 60 miles. Its longest journey was, I believe, 170 miles, and when we reckon that the only accidents which happened to it were on the ground, when the men could not hold it against the wind, whereas a few minutes before it was up in the air steering in all directions, and proving its capability of gliding through a fairly strong wind, it will, I think, be conceded that the Lebaudy airship is a thing to be reckoned with. What could the Lebaudy airship do in war? It has carried as many as seven passengers, but an airship should not be expected to carry so many. As much margin as possible should be left for ballast and motor fuel, also for ammunition.

The airship will certainly play a great part in future European wars. The construction of 100 airships would cost less than a first-class battleship, but I believe they could be

relied upon to do far more damage. The fact that the dirigible balloon has its limitations should not blind us to its capacity. Even the *Dreadnought* has limitations. I am afraid much error is spread by popular sensationalism in newspapers and magazines which lead people to suppose that the conquest of the air is an accomplished fact, and that France and Germany have each a fleet of equipped and manned airships, and that each vessel can easily drop a few hundredweight of shells on battleship or fortress!

Of course, the capacity to carry and discharge explosives is strictly limited. As you lessen the amount of weight carried by the balloon you cannot take in fresh ballast while in the air, any more than you can renew your supply of gas. Yet even with these limitations the dirigible balloon is a war instrument of great potentiality.

It is no easy matter to drop shells on to a small target from a height of 3,000 or 4,000 feet, yet it is necessary to keep at such altitudes in order to be out of range of the enemy's guns. Probably this difficulty will be solved very simply by lowering the ammunition to the end of a long wire hanging perhaps two or three thousand feet below the balloon, and releasing it by electric current when immediately over the desired point. Imagine the destruction that would be caused by a 100 pound shell of dynamite falling on a battleship.

In conclusion, in my opinion there will soon be a keen contest between the Powers in building airships just as there is now in building marine ships. But it is of immense importance to have a staff of practical aeronauts. In war the casualties in the balloon sections will be heavy, and I do see this loophole in the armour certainly of England, and to some extent in that of Germany and France, that not sufficient attention is yet paid to the training of aeronauts.

If war were to break out to-morrow dirigible balloons would be used, but their use would be limited for want of men. A glance at the pictures now to be thrown on the screen will show some typical aerial warships.

DISCUSSION.

The CHAIRMAN (Hon. Charles Stewart Rolls) in opening the discussion, said the author had made out a very strong case for the dirigible balloon, but in his opinion had condemned the heavier-than-air balloon rather too severely. He had mentioned that one of the principal objections to the aeroplane was the risk of the motor stopping, but the possibility of disaster was present to a certain extent in the navigable balloon also. He had been fortunate enough to make a short trip in the French military airship "Ville de Paris," and was very much struck on that occasion by the fact that large navigable balloons were exceedingly at the mercy of the wind if anything happened to the motor. Fortunately, when the engines stopped it had generally been found practicable to repair them in the air, or the day had been a calm one and it was possible for the balloon to come down without difficulty, but there was the risk of a very serious accident if a descent had to be made in anything like a strong wind. As soon as the engine stopped, the airship was practically converted into an ordinary balloon with the difference that in the latter there was a wicker-work car, which was very flexible and protected the occupants, whereas with a navigable balloon it was different, there being a more or less rigid frame, with the result that if it hit the ground there was a very great chance of the occupants being thrown out in the first place, and great risk of some part of the frame being broken, as happened in the "La Patrie." A casting might also be fractured and a part of the propeller shaft be lost. When anything of that kind happened there was a sudden discharge of weight, and the balloon would probably go up to a great height, even if the valve were held open all the time. The descent would then be made considerably faster than before, and as it seemed to him most airships were not provided with a sufficient amount of ballast to properly control the descent, the result might be that there would be a worse bump than before when the balloon came down to the ground for a second time, with the chance of something else being broken. He remembered on the trip to which he had referred passing over a fort, and being very much struck with the ease with which it seemed possible to drop down a bomb and blow it up, although they would probably have blown themselves up at the same time. The author's suggestion of letting down the explosives on a wire a thousand or two thousand feet long before actually discharging them was a very valuable one, as it would enable a much better aim to be made at the place attacked, while the airship would be more out of range of the enemy's guns than if it were level with the explosive. He believed there was no subject on which more patents had been taken out than that connected with aerial navigation, and yet it was a curious fact that the only successful ships at the present time, such, for instance, as the Zeppelin, the Lebaudy, and even the Farman aeroplane, were all operating practically independent of any patent. The credit for the invention of Mr. Farman's aeroplane was really due to two brothers named Voisin, who had designed and built his aeroplane, but who attached no importance whatever to patents, their drawings being frequently published in aeronautical papers. The

Wright brothers held many patents, bnt they did not attach much importance to them. The reason they were keeping such reticence on the question of what their machines would do was, as they had told him, that as soon as experts were able to get near the machines and take photographs of them, the secret of the design would be public. The secret of the success of the machine was in its design, and until the somewhat mysterious negotiations for its purchase had been completed they did not care to let anybody see it. With regard to the vexed question as to whether the heavier-than-air or the lighter-than-air principle was the right one, there was no doubt that for military purposes the latter was preferable, because it had a much greater weight-carrying capacity than any aeroplane could have at the present time. Nevertheless he thought a fast motor-propelled aeroplane would be very useful in the course of time for military reconnoitring and such like work. The author had stated that the fault of these machines was that they could not go high; but personally he could not understand why, when a machine was once off the ground, it should be any more difficult to sail along at a height of 300 feet than 30 feet; in fact, the Wright brothers' machine had no difficulty in soaring up to a height of 300 or 400 feet. The principle difficulty in the aeroplane of the Farman type was the over-heating of the engine. The limitations of weight were such that there was insufficient cooling capacity. The engines carried a very small volume of water, and there was also a very poor radiating surface to keep the water cool. As a result the engine ran for a few minutes, then got hot and slowed down, and the aeroplane necessarily came down to the ground. That was the reason why Farman was never quite certain when he would come to the ground. Another point which would arise in the course of time, when aeroplanes were capable of doing journeys of 100 or 200 miles, was the personal element, the strain in operating one of these machines being tremendous. That was not the case with the Farman engine, because there was no carburetter, throttle, or variation of ignition, everything being set and fixed, so that the aeronaut could devote his attention to balancing and steering; but in an aeroplane of the Wright type there were, firstly, the two kinds of steering—the vertical and the horizontal. The balancing had to be watched the whole time; then the throttle of the engine had to be looked after to adjust the variation of speed, in addition to the adjustment of the mixture for carburation, the lubrication, and many other things. Mr. Wright had informed him it was perfectly possible a machine would be built which would be able to run 150 or 200 miles before it would be possible to find an operator who could run it. The author had alluded to the insufficient attention which was being given to the training of military aeronauts in this country. It must, however, be borne in mind that military ballooning in England was almost entirely confined to captive work, and the training of the officers in the British Army in that respect was second to none. Their training in free runs was very much less, because it was more expensive; and as the grant from the War Office was very small it was impossible for the officers to make more than a very few free trips. There was a scheme on foot at present between the Aero Club and the War Office, under which members of the club who owned balloons and possessed the club's certificate should place themselves at the disposal of the army in case of a military emergency, and by those means the difficulty to which he had referred might, to a certain extent, be overcome.

Mr. CHARLES E. TURNER stated that the *Daily Telegraph* was printing daily some reports of investigations on the atmosphere, from which very illuminating facts with regard to the speeds of air currents at different latitudes might be obtained. It appeared there was a general rule that, at an altitude of a thousand feet, double the wind velocity was obtained that existed on the surface of the ground, and at 2,000 feet three times the speed; so that with a dead calm of eight miles an hour on the surface there was a wind of perhaps nearly thirty miles an hour at 2,000 feet. That was a big speed for any existing dirigible to cope with, and yet at that height it would be by no means out of the range of guns. For that reason he thought aeronauts might be a little unduly optimistic with regard to the part that the dirigible could play in any future war; and it seemed as if at present they would only be of real value when there was an absolute dead calm.

Mr. PERCIVAL SPENCER said it was impossible to criticise the paper adversely, which had been most carefully thought out; but he could not help thinking when looking at the pictures which had been thrown on the screen, that it seemed a pity that the science of ballooning should be developed for the destruction of our fellow creatures when it lent itself more to enjoyment.

Mr. WALTER REID, in referring to the recent lapse of the international restrictions on the use of balloons for war purposes, thought that the restrictions were introduced in a panic, owing to an exaggerated opinion of the damage that might be done by balloons with explosives. In the ordinary mind the power of explosives was considerably magnified, it being said that dynamiters could carry in a small bag enough explosives to wreck a city. Supposing, however, 100 lbs. of explosive was dropped from a dirigible balloon, the balloon would go up suddenly to such a height that it would probably lose its balance, and the aeronaut would be placed in a difficult position. If a fortress were to explode a shell anywhere near the balloon, even if it did not touch it. the concussion of the atmosphere produced by the explosion, even of a small shell, would be a very serious thing to the fabric of the balloon. He agreed with the author that the lifting

power of an aeroplane must be very slight indeed, being dependent, to a great extent, on the speed at which it was going; and naturally, the greater the speed the greater the difficulty in aiming at anything. The author's ingenious idea of fixing an explosive on a wire, some distance below the balloon, ought to be tested practically, if it had not already been tried. The photographs which had been shown were undoubtedly beautiful, but for military purposes they possessed two difficulties—the first being, the perspective was wrong; and the other, that the elevations were not shown. A very clever apparatus had been invented by Captain Scheimpflug, of Vienna, to bring the photographs back to the actual angles in which they existed on the ground, and he had seen some splendid maps based on photographs taken in that way. That was a matter which, in his opinion, was worthy of the study of the British military authorities. He did not think propellers were the most efficient way of applying power to balloons, more than half the power being lost in the friction of the propeller. Another method ought to be devised which would convey the power of the very powerful engines which were now available for aeronautical purposes. It was interesting to hear that the fabric of the French balloon was made in Germany. In this country, goldbeater skin was used as a fabric for war balloons, and this. in his opinion, was the best of all for retaining the gas, although it was expensive. The essential difficulty that existed with regard to aeroplanes was the balancing, nearly all the aeroplanes that were being tried at the present time, being, in his opinion, dangerous. The very first essential to a useful aeroplane was to make it in such a form that it could not readily overbalance. Sir Hiram Maxim had pointed out how that could be done, but inventors did not seem to recognise that that was the way out of their chief difficulty. The question of the cost of gas for balloons was a most important matter. The production of hydrogen from sulphuric acid and iron was a costly process, but several systems had recently been devised for producing hydrogen much more cheaply, and that gas would probably be obtained in time as cheaply as illuminating gas. That would be a very great advantage, because most of the present balloons were filled with ordinary lighting gas, which was not nearly as buoyant as hydrogen, so that the envelope had to be made larger and the carrying power was less. When dirigible balloons were more safe, and possibly of a greater size, the data with regard to air-currents which had been mentioned would be invaluable. The bulk of observations at high altitudes showed that, not only were the winds of a higher velocity, but they were much more regular; and when the time arrived for big passenger balloons, those high air-currents could be utilised much better than they were at present. If large supplies of hydrogen could be obtained at a cheap price, he did not see why passenger balloons should not go over to America, and even beat the ocean liners.

Major BADEN-POWELL remarked that the author had stated that the Zeppelin airship travelled at 25 miles an hour, He had seen it stated in one of the journals that it had travelled at 36 miles an hour, and would be obliged if the author could state what it actually accomplished on its last journey. He also knew that Zeppelin took out several patents for his apparatus. Personally he had peculiar ideas with regard to the stability of aeroplanes, which differed from that of most people. Although he had never practically tried an aeroplane, he was inclined to believe that the question of the stability was not a difficult one. He had made a number of small models which went fairly well, and which, even in a puffy wind, did not upset. The same remark also applied to experiments he had made with gliding machines; in fact it was very difficult to upset a machine so long as it was really well designed.

Mr. T. W. K. CLARKE asked the author of the paper if he was still of the opinion he expressed some years ago, that the general direction of some of the upper currents was north-west? It had been mentioned in the course of the discussion that propellers were very much less efficient in air than in water, but he believed that experiment showed that the efficiency of the propellers in air had been over 70 per cent. A recent American book also gave some very remarkable results, showing that the friction in air varied exactly according to the same laws as the friction in water. Another point relative to the balance of aeroplanes might be noted, namely, that an aeroplane depended for its support upon its area, while a balloon depended upon its volume; from which it could easily be shown mathematically that the weight of balloons would grow in a smaller proportion to their lifting power, while, on the other hand, aeroplanes would tend to grow smaller, since their weight grew faster than their lifting power.

Mr. GAUDRON, in reply to Mr. Turner, said that the upper currents were generally stronger that the lower ones. He thought, however, the current of 30 miles an hour would be experienced at a much greater height than 2,000 feet; but sufficient tests were not made to decide this point. Even a wind of 30 miles an hour would not interfere with a steering balloon, because the Lebaudy airship did 38 miles an hour in 1906, with only a 70 horse-power motor; while the Zeppelin, with a 170 horse-power motor, attained a velocity of 35 miles an hour. If the Lebaudy airship had a 170 horse-power motor, it ought to be able to attain a greater speed. A propeller was probably not the best means of propulsion, and extensive experiments were required to elucidate the point. Proper data would never be attained by simply driving a propeller in a room, because the conditions in the open air were totally different. He did not think, in reply to Mr. Reid, that if 100 lbs. of explosive was dropped from a balloon, the balloon would rise to such an

extent as to inconvenience it, in fact in his opinion it would make no perceptible difference. It was also very difficult to hit a balloon with a shell fired in a gun, because the balloon was moving at a certain speed, and would generally keep out of range. Even if a dynamite shell exploded 100 feet below the balloon he did not think it would cause any damage. He remembered passing over Woolwich at a height of 6,000 feet when the big guns were being fired, but very little concussion was felt. He had tried the experiment of firing by means of an electric current, 2 cwts. of fireworks suspended by a wire from the balloon, and no harm had resulted. Goldbeater's skin was undoubtedly a good material for a small balloon, but it was very expensive for ballooning purposes. For a large balloon it was not strong enough, being very brittle in hot weather, while it fell to pieces after a heavy rain. He saw the Aldershot balloon after it had been exposed to the weather for two or three days, and came to the conclusion that it would have been unsafe to have attempted to have taken taken it back to Aldershot. The speed of the Zeppelin balloon was ten miles an hour in 1898, 14 miles an hour in 1905, and 35 miles an hour in 1906, three miles less than the speed of the Lebaudy airship. Zappelin did take out a few patents; but it was difficult to apply patents to airship work. Five years ago he took out a provisional patent for an expanding airship, which was practically adopted in the construction of the Italia three years later. He believed he mentioned to Mr. Clarke some years ago that the general current was N.W., but the currents varied considerably. Not much definite information was available on the subject, as not enough ascents were made to test the assumption. The data published in American papers was extremely unreliable, most of it being meant for public reading; but when it was practically tested it was proved to be only theory.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Gaudron, for his interesting paper, and the meeting terminated.

IRON AND STEEL WORKS IN EASTERN BENGAL AND ASSAM.

A good deal of interest attaches to a monograph on this subject just issued from the office of the Press Superintendent at Shillong, considering the dearth of official records dealing with the same. Smelting, though formerly general in the hills of the central range and its vicinity in Assam, was apparently unknown in the plains of Eastern Bengal and the Surma Valley. Now it only survives in the district of the Khasi and Jaintia hills and in the Manipur State, and in those places only to a very limited extent, though it is not improbable that it may also still linger in the northern and eastern hills, of which we know little. Forging of implements for purely local requirements is more or less common over the province, though there seems to be little external interchange of ironwork, the smithy generally supplying a particular village or group of villages.

In the North Cachar hills ore is no longer extracted, though it was 50 years ago, while in Upper Assam smelting was an important industry about the same time. In the plains, too, the massive guns and other implements of war and agriculture found in plenty in most centres of population, are evidence of an industry once far more widespread than now.

In Manipur, iron is the only metal yet ascertained to exist, and it is not long since an iron-headed spear thrust vertically into the ground used to be the regular way of locating iron beds by observing the particles adhering to the blade, after the rains had washed the soil away. The present mode is by using a long bamboo skewer. The ore is extracted from pits which seldom exceed 9 feet in depth, and after being washed, a special piece of ground is smoothened, alternative layers of ore and straw are laid, superimposed on one another, and the whole set alight. From the ashes the ore can be picked out without trouble and then pounded. In the Khasi hills, this preliminary burning, probably owing to the greater richness of the ore, is not resorted to.

After that the furnace work begins. The furnace consists of a hollow cylinder of clay, 2½ feet in height and 18 inches in diameter. Two smaller wooden cylinder-bellows connect with this furnace by means of pipes, and the lids of the bellows are fastened to the springy branch of a tree and worked by the foot, or rather feet, of the blower. At the bottom of the furnace a layer of live charcoal is laid and fanned to a great heat, and more charcoal and ore added, but no flux. About 320 lbs. of charcoal are required to turn out 25 lbs. of rough iron. In the Khasi hills much the same system is pursued, but not with sufficient variety to call for detailed notice.

Unlike the working out and smelting of the raw material, forging is spread over practically the whole province, the material used being chiefly imported pig-iron and iron and steel bars brought by the local traders from Calcutta. To a less extent and mainly in the more remote districts broken instruments and scrap-iron in any form are bought up to be remade, and where iron is worked the out-turn helps to swell the product. Charcoal is most generally used as fuel, but where available coal and coke are preferred. The number of forges in the plains is estimated at about 5,350, but in the hills an estimate is not possible owing to lack of data.

THE WATTLE INDUSTRY OF NATAL.

The black wattle tree was transplanted from Australia, and when first introduced into Natal there was no idea of its becoming a valuable commercial asset, but its beauty, combined with its quick growth, made it a particularly desirable tree for ornamental purposes, and with this object in view its growth was first begun in Natal a little over a quarter of a century ago. It may be taken that the commencement of the cultiva-

tion in Natal of wattle plantations dates from the year 1888. From about that period the wattle was intelligently and systematically planted and grown, until in 1906 the acreage in wattle plantations in Natal was 80,762 acres, and this acreage was probably increased in 1907. Wattle bark has now attained to third place in the list of oversea exports from the colony, and there is every indication of a continued increase in the output. The wattle industry gives a quick return, beginning about five years after the tree is planted. The tree needs no replanting, it being a perennial, which the cutting of the first planting does not interfere with. According to the American Consul at Durban, 39 sample packages were sent to London in 1886, and were followed next year by 447 packages. The encouraging and satisfactory reports received from these shipments—which continued to be made in packages until 1896—gave great confidence in the future of the business, and the plantations increased their production considerably. From this modest beginning the output and shipments increased gradually until 1895, when 57,666 packages were shipped. The industry passed through its experimental stages during this period, in which was shipped a total of 168,193 packages, valued at £60,000. There were shipped in 1896 3,378 tons, in 1898 9,427 tons, and in 1902 35,537 tons. In 1904 the shipments were valued at £91,000, in 1905 at £100,000, and in 1906 at £89,000. For the ten months ended October, 1907, they were valued at £125,000. The trees are felled and stripped of their bark gradually after they are five years old. Complete felling will probably take place when the trees are ten years old. The average yield is estimated at half a ton per acre each year. In addition to the bark the wood is valuable when there is a demand for this kind of timber. The cutting must take place when the sap is up, which is between January and August. The bark is then stripped from the entire tree, extending to all limbs of two inches in diameter. The bark in this form is dried; many plantations have large sheds in which to dry it, though sometimes, when the weather is fine, it is dried in the open. When it has become dry—which should occur after twenty or twenty-five days—it is prepared for market, by being ground, cut, or shredded into small bits. It is then packed in bags of about two hundred pounds each, and is ready for export. To prospective buyers a word of warning is, says the Consul, necessary, because some farmers do not take the proper care in curing their bark, and when it reaches the European market it is dark, mildewed, and otherwise damaged; and it has been said that some unscrupulous persons have at times mixed other barks with the wattle. The destination of the bark exported from Natal in the year 1906 was as follows, the countries being given in the order of their importance from the point of view of consumption: — United Kingdom, Germany, Russia, Austria, Belgium, and Mauritius. The quality of the wattle grown in Natal is equal to that produced anywhere, and analyses have shown it to contain as much as 40 per cent. of tannin. At the present time there seems to be no serious competitor to Natal wattle bark, its cultivated and increasing supplies going far to meet the naturally grown and diminishing supplies from the original home of the tree. In the districts of Griqualand and Pondoland in Cape Colony, cultivation of the wattle has been systematically undertaken, but the adaptability of those districts to its growth has not yet been proved. In German East Africa experimental tests have also been made, and bark from there, upon being analysed at Hamburg, has shown from 27 to 41 per cent. of tannin.

ADMIRALTY CHARTS.

The following is the official list of charts issued by the Hydrographic Department of the Admiralty, in December, 1907:—

New Charts.—No. 1202—Scotland, west coast:—Lochs Dinbaig, Grishornish, and Snizort Beg. 955—Norway:—Inner fiords between Rövde and Molde, including Volden, Stor, and Romsdals fiords. Plans: Nes, Sæbo, Merok. 3636—North America, east coast, Gulf of St. Lawrence:—Restigouche river. 2786—North America, east coast, River St. Lawrence, above Quebec:—North of Lanoraie to Ile Bouchard. 2787—North America, east coast, River St. Lawrence above Quebec:—Ile Bouchard to Boucherville. 2426—British Columbia:—Port Simpson and adjacent anchorages. 2114—Baltic entrance, The Kattegat. Plans added:—Skagen harbour, Osterby harbour. 2732—Eastern archipelago, plans of anchorages in Bali Lombok, &c. Plan added:—St. Nicholas, Banjuwedan, and Pegametan bays. 991—Japan, anchorages on the coast of Yezo island. Plan added:—Omu road. 1101—Mariana or Ladrone islands. New plan:—Tanapag harbour. Plans added: Maug islands, Assongsong island, Sarigan island.

Charts that have received additions or corrections too large to be conveniently inserted by hand, and in most cases other than those referred to in the Admiralty Notices to Mariners:—

No. 1787—Ireland:—Wexford to Wicklow. 1772—Ireland, east coast:—Approaches to Wexford harbour. 3038—Norway:—Biörnsund to Kristiansund. 1971—Norway:—Approaches to Trondhjem, western sheet. 2368—Germany, north coast:—Jershöft to Rixhöft. 150—France:—Port and roadstead of Marseilles. 1227—United States, east coast:—Boston bay and approaches. 2482—United States, east coast:—Fletcher's Neck to Cape Cod. 1516—United States, east coast:—Boston harbour. 1097—Gulf of Mexico:—Bay Biscayne to Lower Matacumbe bay. 5279—China, south coast:—Hong Kong waters east. 1602—China, north-east coast:—Approaches to the Yang tse Kiang. 2924—Australia, east coast:—Cape Grafton to Hope islands. 473—Friendly islands:—Lifuka island, anchorage and approaches.

These charts are issued by Mr. J. D. Potter, 145, Minories.

HOME INDUSTRIES.

Farming for Business.—Interesting figures, to be found in the Annual Report of the Board of Agriculture, are those which relate to plots of land of less than one acre. Of these there are nearly one million which might be described as coming within the agricultural area, and an attempt has been made to differentiate between holdings occupied for the primary object of farming as a source of profit, and holdings which may be considered rather as appanages to a residence which increase its amenities and provide occupation and interest to persons whose principal avocations lie in other directions. The results now given for the first time must be regarded as only approximate, but, taking them, it appears that of the total number of holdings included in the returns, 28,403, or 5·67, in Great Britain were returned as not farmed primarily for business. The proportion is largest amongst the smallest holdings. Thus, of holdings between 1 and 5 acres, 11·4 per cent., and of holdings between 5 and 50 acres, 5·7 per cent., are not farmed for business. It is perhaps surprising that as many as 26·35 holdings over 50 acres should be described as not farmed for business, but, as might be expected, the greater number of these, both absolutely and proportionately, are in England. If these figures may be accepted as fairly accurate, they furnish another indication of the extent to which the agricultural land of the country is occcupied for purposes of amenity rather than economic development. The largest proportion of these non-commercial holdings is naturally found in the administrative county of London, where nearly half the small numbers included in the returns are so classified. In Surrey, 25·8 per cent.; in Middlesex, 28 per cent.; in Hertford, 16·9 per cent.; in Berkshire, 15·5 per cent.; in Hampshire, 12·4 per cent.; and in Sussex, 11·3 per cent. of the total number of agricultural holdings are stated to be not farmed for business, but in every other county the number is less than 10 per cent., and in one instance (Shetland) it is nil.

Hops.—The area under hops continues to decline. In 1907 it fell away 1,784 acres, or 3·8 per cent., and the total is again the lowest recorded. The decrease was fairly general, Kent losing 1,127 acres, Hereford 338 acres, and Sussex 136 acres. The report gives a summary of the acreage in each of the more important counties since the returns were first collected, and it shows that whereas, during the last thirty years, there has been a practically steady decline in the South-Eastern group (particularly in Hampshire and Sussex), the Western area has, on the whole, devoted increased attention to the crop. In the decade ended 1876 the acreage, under hops in Kent, was 40,105; in that ended 1906, it had fallen to 30,672, and last year it was 28,169. In Sussex, the acreage has fallen from 10,177 in 1876, to 4,243 in 1907, and in Hants from 2,779 to 1,842; but in Hereford it has risen from 5,839 to 6,143, and in Worcester from 2,452 to 3,622.

Labour Disputes.—It has, of course, been foreseen that with trade reaction there will be serious labour disputes. With lessening orders, employers will seek to reduce wages, and are certain to meet with more or less sustained resistance from the employed. The recent cotton crisis, which threatened such disaster to Lancashire, was not due to these causes, but rather to the demand of a comparatively insignificant section of the operatives to be put on an equal footing, in important respects, with their fellow workmen. Elsewhere the situation is different, and the directors of great industries, with the prospect before them of a period of stagnation, have satisfied themselves that wages must be reduced. The first steps have been taken by the shipbuilders on the north-east coast. Six of the smaller trades in the industry, the most important of which, numerically, are the shipwrights and joiners, struck work last week against a demand for reduction of wages. The employers have met this action by serving notices upon all classes of artisans in their shipyards to cease work. These notices were posted last Saturday, and are to be enforced at the end of fourteen days unless, in the meantime, some agreement with the trades on strike is arrived at. Failing such agreement, some 30,000 men on the Tyne, the Tees, and at Hartlepools, will be thrown out of work. In ordinary times, there are about 46,000 men employed in the area concerned. Deducting 13,000 engaged on the Wear, who are outside the dispute, being subject to the decision of the Conciliation Board, and some three or four thousand men already on strike, the threatened lock-out means the displacement of nearly 30,000 men. Allowing five to a family a strike would affect nearly 150,000 persons. It is to be hoped that the spirit of conciliation and compromise will prevail, and that before the time arrives for the lock-out notices to take effect an agreement will be arrived at. On the face of it this does not seem an opportune time for a strike, having regard to the present scant demand for tonnage, and it is believed that a slight concession on the part of the employers would avert the threatened struggle. Unfortunately it is not only in the shipbuilding yards that there is trouble between master and man. The Engineering Employers' Federation held, in London on Friday last, one of their periodical conferences with the Executive Committee of the Amalgamated Society of Engineers and representatives of the United Machine Workers' Association and the Steam Engine Makers' Society, under the agreement of 1898. The business was to consider the proposed reduction of wages on the north-east and north-west coasts. An official statement was afterwards issued which stated that "after considerable discussion certain proposals were submitted upon which the parties failed to agree, and which are to be sent to the men to vote upon." Here again it is understood that the employers would be content with a very small reduction, but the men are disinclined to agree to any. The voting papers are returnable on the 17th and 18th February.

Sweating Industries. — Having regard to the support given to the principle of the Bill by leading Unionists, it is probable that Mr. Toulmin's Sweated Industries Bill, which is substantially the same as that introduced by Mr. Henderson last year, will be generally supported in the House of Commons, and, with some amendments, become law this year. It provides for the establishment of Wages Boards, with power to fix the minimum rate of wages to be paid to workers in particular trades. It will apply in the first instance only to certain specified trades — tailoring, dressmaking, and the making, altering, trimming, finishing, and repairing of shirts — but it is proposed to give the Home Secretary power to say what other trades shall be included in its provisions. The Wages Boards are to be composed of representatives of employers and employed in equal numbers, with chairmen chosen by the members, or, in default of agreement, nominated by the Home Secretary. Each board is to have power to fix minimum rates for any single kind of work, and is to have the widest discretion as to fixing time or piece-work rates, and as to varying the minimum according to the locality, the kind of work, and the persons employed. The enforcement of the payment of the minimum rate is to be entrusted to the inspectors. Meantime, it is to be feared that Acts intended to protect the helpless are often evaded, and in no direction oftener than in that of hours of employment. There are few trades in which women and girls are so overtired by excessively long periods of employment as in the small drapers' and milliners' shops where one or two workers both serve as shop assistants and trim hats. In her report, to be found in the last annual report of the Chief Inspector of Factories and Workshops, Miss Vines gives a particularly bad instance of the long hours worked by young girls in a millinery workshop, and in the large shop attached. Girls of 14 and 16 were employed in millinery work and in serving customers from 9 a.m. to 10.15 p.m. on Saturdays, with under two hours for meals. The employers followed the usual custom in such cases, and by forbidding several of the girls to touch a needle on Saturdays, and permitting them only to serve in the shop, they at once placed their young assistants, for that particular day, outside the protection of the Factory Act. Miss Vines reports a visit to Lambeth late on Saturday night, when she inspected a small millinery shop, and found that quite young girls, with faces careworn and sad before they were women, were employed there till midnight every Saturday. There was also employment from 9.30 to 1 every Sunday morning. The workers did no sewing on those two days, and so were exempt from the regulations of the Factory Act. With reference to the Sunday employer, the occupant observed that as the fine imposed was so small, he "did not mind" about it, and it would pay him best to be fined, and keep his shop open.

CORRESPONDENCE.

THE REFORM OF THE PATENT-LAW.

I am sorry I cannot see my way to echo all the eulogies which have been passed, both by the able author of the paper and by the distinguished Chairman, upon the Patents and Designs Act, 1907.

The author pointed out in reply to one of the speakers that the Act undoubtedly tended to curtail the rights of patentees, a remark in which I entirely agree; but I do not think the extent of this curtailment is realised.

The Board of Trade have by an extensive system of circularising sought to convey to the public an entirely different impression. The circular to which I allude, after referring to the provisions for the revocation of patents worked wholly or mainly abroad, to compulsory licenses and revocation, to covenants in restraint of trade and to certain other matters, proceeds to state that "the Act contains a large number of provisions which will improve the position of existing and future patentees and proprietors of registered designs." In my opinion, it contains a large number of provisions calculated to facilitate attacks upon and the abrogation of patent rights; and I cannot but anticipate that it will, on the whole, prove highly detrimental to the introduction and development of new industries.

It is scarcely possible for anyone familiar with the previously existing status of patentees or patent-proprietors to peruse and study the Act without acquiring the idea that it might have been entitled "An Act for facilitating the Revocation of Patents." The grounds upon which proceedings for the revocation of a patent may be based are largely increased in number; and it seems to me manifest that the effect of such legislation must be to render patent property more unreliable, and consequently to deter persons from embarking capital in the establishment of new industries based on patents.

I will not attempt to deal with all the new grounds upon which proceedings for the revocation of a patent may be instituted; but the provision for the revocation of patents worked exclusively or mainly outside the United Kingdom, having been fully discussed and, as I understand, approved by Mr. Gordon, may be taken as an example. During a practice of thirty years, I have scarcely ever known of a manufacture being established in any country simply because the Patent-law of that country contained a condition rendering working within a certain time obligatory. I have, however, known scores upon scores of patents which have been abandoned in consequence of the existence of such a legal requirement. One of the primary objects of the grant of Letters Patent is to afford an inventor some inducement to exert himself to procure the establishment of the industry concerned. Destroy his patent, and such inducement is not only taken away, but the position becomes

one in which it is not worth anyone else's while to attempt to establish the industry, seeing that even temporary protection would be unobtainable. Even were the patent to remain unworked to the end of its natural life, its existence did no one any harm, and there always remained the possibility of its acting as an inducement to the patentee or to some licensee to make some attempt to establish the industry to which it referred.

The Chartered Institute of Patent Agents have upon every suitable occasion drawn attention to the wholly futile and utterly pernicious effect of obligatory working; and there is probably no body of business men who have had better opportunities of judging of the injurious effect of such a condition upon industrial enterprise. They believe that a provision for the grant of compulsory licenses, coupled with appropriate machinery for its administration, would have met all reasonable requirements, even of those who have been most persistent in the recent agitation. The complaint of the chemical manufacturers was that German products — the results, it should be bore in mind, of German discoveries—were imported into this country, but were not manufactured here; patents being taken solely with the object of preventing manufacture in this country. It is fondly thought that the new provision whereby patents worked under such conditions are threatened with revocation will remedy the evil complained of. The real evil is that the German chemists make the discoveries, whilst the English chemists do not. It has been estimated that 95 per cent. of what I may call "chemical patents" originate abroad, which means that only 5 per cent. of them originate in this country. The real cause of the trouble is ignored, and then a wholly wrong and highly mischievous remedy is applied! One of the conditions upon which a patent is granted is that a specification, fully disclosing the invention, shall be lodged at the Patent Office, so that, at the end of the term of monopoly, the public may arrive in a position to practise the invention. If authors of chemical discoveries, who are said to be in the proportion of 19 foreign to one British, are subjected to conditions which, from their point of view, will be regarded as not only vexatious but as prejudicial to their interests, they will in all probability withhold the very information which our own chemists appear to lack, and elect to carry on their manufactures as secret processes. There are, of course, methods of manufacture which become obvious on examining the results produced; but this is not so in the case of chemical dyes and of many other chemical products. Bearing this fact in mind, one might have been disposed to imagine that the chemical industry in this country was precisely the one which could least afford to encourage the non-disclosure of discoveries by foreigners; but however that may be, it is not merely chemical patents but all patents which, to appease the Manchester outcry, have been subjected to conditions which will undoubtedly render capitalists even less inclined than they are at present to risk money in the establishment of new enterprises based upon patents.

I have only discussed one of the new grounds for revocation, but there are several others, and it is from a broad view of the Act, and not from the consideration of any one section in particular, that I am regretfully forced to the conclusion that, instead of advancing industrial enterprise, it will prove highly detrimental thereto.

Our patent system undoubtedly called for considerable amendment, but the measure which has been passed, and which has been followed by the official issue of thousands of laudatory circulars, is, in my humble view, in many respects of a retrograde, and in others of a harassing, character.

A patent system adapted to foster industrial enterprise should, I submit, be one so designed as to result, first, in the issue of good and valid patents, and secondly, in their easy maintenance. "Good and valid" is largely dependent on the efficiency of the arrangements controlling the issue of the patent. "Easy maintenance" implies very moderate renewal fees (if any), and protection from vexatious and harassing attack. My leading idea would be: "Encourage Maintenance." The leading idea of the framers of the new Act appears to have been: "Facilitate Revocation."

G. G. M. Hardingham.

Clun House.
31st January, 1908.

The present writer is almost alone amongst members of the patent profession in approving a system of compulsory working of patents in this country, which he has advocated for some years, provided the conditions are not too onerous. He is of opinion, however, that Sec. 27 would have been better if there had been no arbitrary limit of twelve months mentioned, and it is hoped that the patentee will in all cases be given ample opportunity of justifying the cause of the non-working of his patent. There is a textual ambiguity as to whether the period of grace can or cannot be extended beyond twelve months, for it will be noticed that the Comptroller is empowered to give an order of revocation which is either absolute or conditional. A conditional order of revocation will specify a reasonable interval, within which the manufacture must be carried on, and if such interval is found to be inadequate, a subsequent conditional order will be made extending the time "for such period not exceeding twelve months as may be specified in a subsequent order." It is open to question whether this signifies a further twelve months or whether two conditional orders provide for a maximum of twelve months together. This point is exceedingly important to foreigners holding English patents. Mr. Gordon passed some severe strictures on Sec. 19 relating to "Patents of Addition," but, if the writer is not mistaken, he did not mention the fact that an

intending applicant remains at liberty to apply for an ordinary patent as heretofore, and, therefore, the mere option of taking out a "Patent of Addition" can do no harm.

ARTHUR H. STANLEY.

38, Chancery-lane, W.C.

OBITUARY.

SIR HENRY TYLER.—Sir Henry Whatley Tyler, late captain R.E., died at his residence, Linden-house, Highgate-road, N.W., on the 30th ult. He was born on March 7, 1827, and was educated at the Royal Military Academy, Woolwich. In December, 1844, at the age of 17, he was gazetted lieutenant in the Royal Engineers, and in April, 1853, when he was promoted captain, he was appointed a Government Inspector of Railways by the Board of Trade. He retired from the Army in 1867 and became Chief Inspector of Railways in 1871, a post which he retained until 1877, when he retired from official life and was knighted. He was president of the Grand Trunk Railway from 1877 to 1895, deputy-chairman of the Great Eastern Railway, chairman of the Westinghouse Brake Company, and he was similarly connected with several other companies. He was M.P. for Harwich from 1880 to 1885, and for Great Yarmouth from 1885 to 1892. Sir Henry Tyler was elected a member of the Society of Arts in 1869. In 1874 he read a paper on "Simplicity as the Essential Element of Safety and Efficiency in the Working of Railways," and in 1877 one on "Continuous Breaks for Railways." He took the chair on several occasions, and frequently joined in the discussions at the evening meetings of the Society. He also contributed many technical articles on railway and kindred subjects to the *Quarterly Review* and other magazines.

GENERAL NOTES.

TEAS IN 1907.—The highest price of tea in 1907 was the highest since 1899. This would seem to imply good results for all producers, but this is not necessarily the case since one of the chief features of the past year was the high price ruling for common grades. The price of medium kinds was depressed, but taking the industry as a whole it would seem that the depression which has ruled for many years has at length passed away, for production has shown little increase during the past year, while consumption, both at home and abroad, has materially increased. The lower duty resulted in a considerable increase in the home demand in 1907. In their review of the year Messrs. Gow Wilson and Stanton point to the great expansion in the use of British teas abroad as one of the most remarkable features of the past two years. This rose from 129,884,250 lbs. in 1905 to 162,461,824 lbs. in 1906, and about 171,500,000 lbs. in 1907. When it is remembered that in 1890 the total consumption of Indian and Ceylon teas abroad was only 14,001,132 lbs., the progress made is startling. The expansion is largely due to the energy with which these new markets have been exploited. No industry has done so much to push its products in foreign markets as Ceylon.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 12.—"The Application of Science to Foundry Work." By ROBERT BUCHANAN, President, Staffordshire Iron and Steel Institute. H. GRAHAM HARRIS, Member of Council, will preside.

FEBRUARY 19.—"The Law of Treasure Trove." By WILLIAM MARTIN, M.A., LL.D.

FEBRUARY 26.—"The Problem of Road Construction, with a View to Present and Future Requirements." By PROF. H. S. HELE-SHAW, LL.D., F.R.S., and DOUGLAS MACKENZIE. The HON. RICHARD CLERE PARSONS will preside.

MARCH 4.—"Modern Dairy Practice." By LOUDON M. DOUGLAS.

MARCH 11.—"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By ERNEST R. MATTHEWS, F.R.S.E., Assoc.M.Inst.C.E.

MARCH 18.—"Impressionist Painting: its Genesis and Development." By WYNFORD DEWHURST, R.B.A.

MARCH 25.—"Recent Improvements in Decorators' Materials." By A. S. JENNINGS.

APRIL 1.—"The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 13.—"The New 'Imperial Gazetteer of India.'" By RICHARD BURN, I.C.S. (To be read by WILLIAM FOSTER.) The RIGHT HON. SIR ALFRED C. LYALL, G.C.I.E., K.C.B., will preside.

MARCH 12.—"Progress of Native States during the past Forty Years." By SIR DAVID W. K. BARR, K.C.S.I., Vice-President of the Council of India.

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

February 25. — "Irrigation in Egypt under British Direction." By Sir Hanbury Brown, K.C.M.G. The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., will preside.

March 24.—"The Mineral Resources of Western Australia." By the Hon. C. H. Rason, Agent-General for Western Australia.

April 7.—"The Imperial Problem of Asiatic Immigration." By Richard Jebb.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

February 18.—"Banners in Pageantry." By George W. Eve. Walter Crane, R.W.S., will preside.

March 31.—"Enamel Portraits." By Cyril Davenport, F.S.A. Sir Hubert von Herkomer, C.V.O., R.A., will preside.

April 28.—"Lace as a Modern Industry." By Miss Isemonger.

May 26.—

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Henry Hardinge Cunynghame, C.B., "The Theory and Practice of Clock Making." Six Lectures.

Lecture IV.—February 10.—Method of compensating pendulums for the expansion of the rod, the bob, and the temperature of the air—Barometric correction—Method of construction of pendulum—The gridiron, the mercury, the zinc and steel, lever and other pendulums.

Lecture V.—February 17.—The pendulum continued—Modes of suspension—Air-tight cases—The escapement—Principle of the escapement; effect of disturbances—The dead-beat escapement—Detached escapements and gravity escapements—The escapements of Mudge, Cummings, Bloxam, and Denison.

Lecture VI.—February 24.—The theory of escapements concluded—Teeth of wheels—The theory of epicycloidal teeth — Involute teeth — Lantern pinions—Electric clocks—Main divisions of electric clocks—Difficulties to be contended with—The clock of the future.

Shaw Lectures on Industrial Hygiene.

Friday evening at 8 o'clock :—

February 28.—"The Removal of Dust and Fumes in Factories." By John Scott Haldane, M.A., M.D., M.R.C.P. (Edin.), F.R.S.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Henry Hardinge Cunynghame, "The Theory and Practice of Clock Making." (Lecture IV.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Messrs. H. Colley Brierley and W. H. Christy Clay, "The Railway Fires Act, 1905."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Laurence Gomme, "The Story of London Maps."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. P. C. Mitchell, "Ruminating Animals."

Tuesday, Feb. 11...Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. F. E. Pargiter, "The Nations of India at the Battle between the Pandavas and Kauravas."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Stirling, "Membranes: their Structures, Uses, and Products." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. A. Alexander Low Dickie, "The Erection of the Pwll-y-pant Viaduct on the Brecon and Merthyr Extension of the Barry Railway." 2. Professor T. Claxton Fidler, "Notes on the Erection of Cantilever Bridges."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Mr. S. S. Thorburn, "Education and Good Citizenship in India."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Wednesday, Feb. 12...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Robert Buchanan, "The Application of Science to Foundry Work."

Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Discussion on "River Pollution, with special Reference to the Board proposed by the Royal Commission," introduced by Sir William Ramsay.

Japan Society, 20, Hanover-square, W., 8½ p.m. Prof. E. Foxwell, "Reminiscences of Lafcadio Hearn."

Auctioneers' Institute, 34, Russell-square, W.C., 7¾ p.m. Mr. W. Gandy, "Ceramics in Architecture and Decoration."

Thursday, Feb. 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Mr. Richard Burn, "The New 'Imperial Gazeteer of India.'" (To be read by Mr. W. Foster.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Canon Benham, "Newgate."

Royal Institution, Albemarle-street, W., 3 p.m. Major Martin Hume, "The Story of the Spanish Armada." (Lecture III.).

Mathematical, 22, Albemarle-street, W., 5½ p.m.

Friday, Feb. 14...Royal Institution, Albemarle-street, W., 9 p.m. Dr. C. W. Saleeby, "Biology and History."

Astronomical, Burlington-house, 5 p.m. Annual Meeting.

Junior Institute of Engineers (at the Rooms of the Architectural Association, Tufton-street, Westminster, S.W.), 8 p.m. Joint Meeting. Mr. P. J. Waldram, "Suggestions as to How the Architect and Engineer may Combine."

Physical, Royal College of Science, South Kensington, S.W., 8 p.m. Annual Meeting. President's Address.

Saturday, Feb. 15...Royal Institution, Albemarle-street, W., 3 p.m. Mr. S. Brinton, "The Art of Florence." (Lecture I.).

Journal of the Royal Society of Arts

No. 2,882. VOL. LVI.

FRIDAY, FEBRUARY 14, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 17, 8 p.m. (Cantor Lecture.) H. H. CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." (Lecture V.)

TUESDAY, FEBRUARY 18, 8 p.m. (Applied Art Section.) GEORGE W. EVE, "Banners in Pageantry."

WEDNESDAY, FEBRUARY 19, 8 p.m. (Ordinary Meeting.) WILLIAM MARTIN, LL.D., "The Law of Treasure Trove."

Further details of the Society's meetings will be found at the end of this number.

SHAW LECTURES.

On Friday evening, 7th instant, Mr. WILLIAM BURTON, Chairman of the Joint Committee of Pottery Manufacturers of Great Britain, delivered the third Shaw Lecture on "The Hygiene of the Pottery Trade."

The lecture will be printed in a future number of the *Journal*.

CANTOR LECTURES.

On Monday evening, 10th instant, Mr. HENRY HARDINGE CUNYNGHAME, C.B., delivered the fourth lecture of his course on "The Theory and Practice of Clock Making."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, February 13th. The RIGHT HON. SIR ALFRED C. LYALL, G.C.I.E., K.C.B., in the chair. Mr. RICHARD BURN'S paper, "The New 'Imperial Gazetteer of India,'" was read by Mr. WILLIAM FOSTER.

CANTOR LECTURES ON THE MICROSCOPE.

Mr. Conrad Beck's Cantor Lectures, on "The Theory of the Microscope," have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C.

A full list of the Cantor Lectures, which have been published separately, and are still on sale, can be obtained on application.

PROCEEDINGS OF THE SOCIETY.

SHAW LECTURES ON INDUSTRIAL HYGIENE—II.

LEAD AND PHOSPHORUS POISONING, WITH SPECIAL REFERENCE TO THE MANUFACTURE OF LUCIFER MATCHES.

BY THOMAS OLIVER, M.A., M.D., F.R.C.P.,
Physician Royal Victoria Infirmary, Newcastle-upon-Tyne.

Delivered on Friday evening, Dec. 13, 1907.

The number of cases of industrial plumbism is still too large for public opinion to be satisfied, or for members of Parliament and persons who have Industrial Reform at heart to feel that all has been done to check the ravages of lead. The Council of the Royal Society of Arts is to be congratulated in thus endeavouring through this course of lectures to arouse interest in the subject of Industrial Hygiene, and by diffusing information, thereby to promote indirect the health of the workers. It is only proper that Great Britain, which was the pioneer of factory legislation, should not be behind other countries in Industrial Hygiene.

The subject assigned to me to-night is "Lead and Phosphorus Poisoning, with

special reference to the manufacture of Lucifer Matches." As Mr. William Burton, the well-known chemist and tile manufacturer, is to lecture on Pottery, I will not deal with the subject of lead poisoning in pottery workers.

Lead mining in Great Britain is no longer the prosperous industry it used to be. It is an old industry, for it goes back to the date of the Roman occupation of the country. British ore is poor in silver compared with the ores brought from Spain and Greece, or with that which is found at the Broken Hill mines in Australia. It pays the owners of rich ores to extract the silver and sell the lead as a by-product. Partly in consequence of this, and of the financial losses incidental to working lead mines in recent years in this country, also owing to the fact that no deleterious gases are given off by the rock, the ventilation of lead mines has never been so well attended to as that of coal mines.

Lead miners lead a hard life, especially in the North of England. They are a thrifty and a frugal class of men. The lead mines in the dales of Durham are in rather inaccessible parts of the country where house accommodation is frequently scanty. As a consequence the men have often long distances to travel to and from their work, and in the winter months are much exposed to the cold winds that sweep down the dales. Close to the mine shaft, in some places, barracks have been erected where the men live for five days in the week, but the sleeping rooms are overcrowded and ill-ventilated, and to this circumstance, as well as to exposure to cold, is to be attributed the high death-rate from phthisis and respiratory diseases of lead miners. The work in the lead mine, too, is fatiguing. Entrance into the mine is usually effected by descending 12-16 ladders, and as there is no system of through ventilation in the mine, the air in the "workings" is polluted by the smoke from the candles and the gunpowder used as an explosive, also by the respiratory products given off by the workmen themselves. It is after a day's work under conditions such as these, that the miners, heated and tired, are obliged in order to get out of the mine to lift themselves up 12-16 ladders, and betake themselves to the poisoned rooms of a barracks, or undertake a long walk home across exposed moorland country. The lead miner of Great Britain does not suffer from plumbism, but he is liable to rheumatism, pulmonary tuberculosis, and to a form of lung disease caused by the inhalation of dust, and known as pneumoconiosis.

So far as the lead workers are concerned, it is with the smelting of the ore that the risk of saturnine poisoning commences. Many of the lead smelting works are situated in the country. From the furnaces there are flues to carry away the fumes. Frequently these flues are chambers of considerable height, and they may be half a mile or more in length. A tall chimney on an adjoining hill will in all probability be found to be the exit for the fume from the smelting works. From one ton of lead ore there may be given off as much as 130 lbs. of lead in the form of fume. The fume contains lead in the form of sulphate and oxide, and most of this is deposited in the flues; hence the necessity for the great length of these chambers. The fume which escapes from the tall chimneys already mentioned has frequently caused poisoning of cattle that have grazed upon the pasture in the neighbourhood of lead-smelting works, a circumstance which has entailed a heavy expense upon manufacturers in Durham, Leadhills in Scotland, and Bleiberg in Belgium, owing to their having been obliged to pay damages to the farmers for the loss of their stock. In order to recover the large amount of lead deposited from the fume in the flues, the conduits have to be entered periodically by men and cleaned. This is a dangerous occupation, for by the time men have been in the flues an hour or two they often come out ill, suffering from severe headache and vomiting. It is undesirable that men should be allowed to remain in these chambers for longer than two hours at a stretch. They ought also to wear respirators.

At this Austrian lead-smelting works near Gailitz, which I show in the lantern slide upon the screen, the smelting of the ore is done upon an American hearth by what is known as the Rossi system, and there is no destruction to either vegetable or animal life in the neighbourhood. The ore and charcoal are placed together in the hearths. The ore contains 73 per cent. of lead, and of this 63 per cent. is recovered at once as pure metallic lead; 7·5 per cent. leaves the furnace as fume, of which 3·7 per cent. is captured by forcing the fume through water and a series of bent tubes and chambers. The hearth is open all round, and is not, as in British smelting shops, built close into the wall. Unlike the English smelting furnaces, the Austrian have two concentric hoods, and by this means the furnace-men are protected from down-cast fume, and, therefore, do not suffer from lead poisoning.

At other works in Austria, which I also show upon the screen, considerable quantity of fume escapes into the air and, as a consequence, vegetation in the neighbourhood is destroyed and no domestic animal can live near the factory. The dust taken from almost any part of this factory contains a large quantity of lead. Owners of British works might study with advantage the methods of smelting the lead ore which prevails in Austria.

The manufacture of white lead is regarded as one of the most dangerous of occupations. Although an old and a comparatively slow method, the manufacture of white lead by the Dutch process has not been surpassed. The first stage consists in making up the "blue beds." Upon the floor of a large chamber, one side of which is completely open, tan is strewn, and upon the tan are placed rows of earthenware jars containing a small quantity of weak acetic acid. Thin strips of metallic lead are laid upon the open mouths of the pots and over both are laid thin planks of wood. Tan is strewn upon the planks of wood, and upon these are placed another series of pots and strips of metallic lead, which in turn are also covered over by planks of wood. In this way tier after tier is reared until the ceiling is almost reached, when the open side of the chamber is closed by wooden planks or doors. The chamber is kept closed for 13 or 14 weeks. The acetic acid as it evaporates acts upon the metallic lead, and converts some of it into the soluble acetate; but as the temperature in the "blue bed" rises owing to fermentation, carbonic acid is given off, which, acting upon the lead acetate, converts it into the carbonate, or the white lead of commerce. When, after 14 weeks, sufficient conversion is supposed to have taken place, the doors are opened, and the chambers, no longer called "blue beds" but "white beds," are entered by the workpeople, the planks and tan are removed, and the white lead is found as an incrustation upon the remains of the strips of metallic lead. Formerly women were employed in the white beds to strip off the white lead, but as the work is dusty, and therefore dangerous, women's labour in this particular department has been interdicted by the Home Office. Men only are now allowed to empty the white beds. To keep down dust, it is absolutely necessary to have water spraying. The lead carbonate is taken from the white beds to the wash-tubs, where it is washed and crushed so as to form a pulp. Jars are filled with this pulp, and taken to the stoves. The stoves are chambers which contain numerous shelves, and upon these shelves the jars are placed. When the stoves have been filed, the iron doors are closed, and kept closed for two days, during which they are heated to a temperature not less than 70° C. When the white lead has been sufficiently dried, the stoves are entered; the jars are taken down, and carried to the grinding sheds and emptied there. Here the dried product is ground and packed into barrels, to be sold as "white lead," or it is mixed with oil to form paint. The emptying of the stoves is also a process that is dangerous to health. I have known young women work only a few weeks in the stoves when they became the victims of lead poisoning, to which some of them succumbed. This, too, is one of the departments of a white lead factory in which women are by Home Office regulations not allowed to work. Before workmen are permitted to enter the stoves for the purpose of removing the dried white lead, the doors must be opened for a few hours previously, and the temperature allowed to fall. The men, too, should be made aware of the dangerous nature of the work and informed of the necessity of creating as little dust as possible. Mechanical stoves should be introduced. It is dust which is the dangerous element, hence the desirability of laying it wherever possible, or of removing it, as in the packing department, by means of tightly-fitting hoods placed over the barrels, or by conducting the packing in closed chambers.

Since dust is the enemy to be avoided, all white paint in this couutry might quite well be made by the Besançon method. A few years ago I had the opportunity of visiting the white lead works of Messrs. Expert Besançon et Cie, Paris, and there I found that the white lead was taken direct from the "white beds" to the mills and crushed under water. The pulp as it escaped travelled on through a series of rollers, being continually washed by the way. At a certain point oil was added, and as the compound still travelled on through other rollers, more and more oil being added, so that ultimately the water was replaced by the oil, there escaped from the last roller, practically speaking, finished white paint, for it contained the merest trace of moisture. There is no dust raised in the process, and there is no handling of dry material. The rollers are self-feeding, and the mixing with oil is done automatically. The consequence is that there is no illness among the men.

Red lead is made by melting metallic lead in an oven in the presence of air. Through the open door of the oven, men with long iron implements keep raking up the molten mass so as to bring it into contact with the oxygen of the air. By degrees, the metal is converted into red lead. It takes about seven to eight hours for the conversion to be complete. The workmen are exposed to the fumes escaping when the doors of the oven are opened. For this reason, the mouth of the oven should be hooded, so as to carry away the fume, and the men should stand back a considerable distance. Two per cent. of the cases of lead poisoning notified to the Home Office, occur in red lead workers. Alcoholic intemperance predisposes the men to plumbism.

It is hardly expected that in a lecture like this I should take up your time with a detailed description of the symptoms of lead poisoning. One of the earliest signs that a person is going under the influence of lead is pallor of the face. A degree of bloodlessness with swarthiness is established, and with this there is a loss of the normal expression. The blood becomes pale and poor in red corpuscles. Sooner or later colic is by most patients experienced. The abdominal pain is occasionally extremely severe ; the patient writhes in agony. Usually accompanying the colic there is constipation, but this is not the cause of the colic, as some writers assert, for in some instances I have found diarrhœa ; also in others that movement of the bowels by aperients does not always relieve the pain. When the pain is severe, relief may be obtained by warm applications to the abdomen, or by a warm bath. Sometimes the colic may be so severe as to require the administration of morphia hypodermically. After the attacks of colic or without them, the patient becomes paralysed in his hands and wrists. The hands fall helplessly by the side of the body. This constitutes what is known as "wrist drop." So completely paralysed is the individual that in many cases he can neither feed nor dress himself. He lies like a log in bed, unable to do anything for himself. This is the commonest form of lead paralysis, but occasionally the muscles of the shoulders, and those of the feet and legs are affected, so too those of the trunk. Lead paralysis differs from that caused by arsenic and by alcohol, in so far as in the latter it is the feet that are usually affected—constituting "ankle drop," as opposed to the "wrist drop," of plumbism. The worst effects of lead are seen in the nervous system. When young women were allowed to work in the white lead works, occasionally one of them would come home after a day's work in a condition of over-excitement bordering upon hysteria. She would laugh or cry without any apparent cause, be excited and nervous, and complain of severe headache. Within two days, the patient who had exhibited these symptoms would probably be dead, for with or without this toxic hysteria, which generally masks a deeper implication of the nerve centres, convulsions would come on, and proceed to coma, from which the patient might never rally. In cases where consciousness was regained, it was often attended by blindness which might, or might not, be permanent. Ten years ago it was not uncommon to find, in the workhouse hospitals, comparatively young women rendered blind for life by lead. The "brain" form of lead poisoning, I have just alluded to, is what is known as "saturnine encephalopathy." After death, lead is found in the brain and other internal organs.

Serious as the effects of lead often are upon individual persons, they are most disastrous upon the life of a community. There is in one sense a national side to this question of plumbism, for lead exercises a blighting influence upon motherhood. When women were allowed to work in white lead factories, I found that, if they were pregnant, they hardly ever went to the end of term—they miscarried —or, if they went to the end of pregnancy, the child was either stillborn, or died shortly after birth in convulsions. It was this circumstance and the greater predisposition of the female sex to plumbism that led me to recommend the abolition of women's labour in the dangerous departments of white lead factories. My recommendations were severely criticised at the time by employers on the ground that any interference of such a kind as I had proposed would, by the compulsory employment of male labour, increase the cost of production and ruin the trade. To-day white lead manufacturers have in many instances expressed their gratitude to me for having helped to make the industry more healthy, and for having removed from this trade female workers. The women were more frequently ill than the men, and their illness was often of a more serious nature.

Lead gains an entrance into the human body through the alimentary canal, the respiratory organs, and the skin, hence the necessity of washing the hands before

eating, of keeping down dust in the works as far as possible, and of attention on the part of workers to details of personal cleanliness.

There is one point that is deserving of notice, and that is how long can lead lie latent in the system without giving rise to symptoms? I have recently had a married woman, aged 36, under my care in the Royal Infirmary, Newcastle-upon-Tyne. She was admitted on account of double vision, paralysis of the muscles of one eyeball, and severe headache. I recognised her as an old white lead worker, who had been under my care in the infirmary seventeen years previously, suffering from colic, blindness, and paralysis. After recovery from a severe illness she did not return to the lead works. She married and became the mother of several children. Neither she herself, her husband, nor children have been since then brought into contact with lead. Her own health has been excellent, for during the last seventeen years she has never required a doctor, except at her confinements. As I could find no cause for the double vision and paralysis of ocular muscles, alcohol and syphilis being readily excluded, I thought that the case might be, notwithstanding the long distance of time since which she had suffered from lead poisoning, one of plumbism, and on sending her urine to the Professor of Chemistry at Armstrong College for analysis, Dr. Bedson reported to me that the urine contained lead. It would appear, therefore, as if, although the patient had recovered from the old attack, a certain amount of lead must have been lying dormant, and stored up in her system, and that some change had occurred in her metabolism whereby the lead was re-dissolved, gained fresh entrance into the blood, and again set up poisoning. This circumstance is interesting from the point of view of the Workmen's Compensation Act.

Substitutes for White Lead.

This is a subject to which the Society of Arts, years ago, gave thoughtful consideration, and the fact that I am lecturing here to-night on "Lead Poisoning" is a proof that the Society's interest in the matter has not entirely waned. Since the largest amount of white lead manufactured is used for making paint, and painters as a class have suffered severely and often fatally from plumbism, the question has frequently been debated as to whether it is not possible to find a substitute for white lead—some substance that would give equally as good covering power, be resistant to the action of the weather, mix well with oil, be not more expensive, and be harmless to those who use it. Zinc white has been recommended. When I was a member of the White Lead Committee of the Home Office, the substitution of oxide of zinc for lead carbonate was carefully enquired into by the Committee, and a considerable amount of evidence was taken from paint manufacturers, master painters, and working painters, the trend of which was to show that for internal decorative purposes zinc white answered remarkably well, but that for outside work no paint answered so well as that made from white lead. In France the replacement of white lead by zinc white has been much discussed in the Chamber of Deputies. Bill after Bill has been carried through this Chamber in favour of zinc white for all painting purposes, inside and outside, but the Senate has always thrown back the Bill. The dispute has become a national question. As far back as 1835, Leclaire demonstrated the harmlessness of zinc and its capability of replacing lead carbonate in the painting of buildings, but the suggestion itself is of even earlier date than this, for it was Guyton Morveau, the distinguished rival of Lavoisier, who first made it. Our Gallic neighbours are at present experiencing what a difficult thing it is for a legislative body to interfere with the customs of an old established trade and to alter the opinions of a people. The greatest argument in favour of zinc white is its harmlessness compared with lead carbonate. The arousal of public opinion across the Channel has done good, since it has already made those who manufacture and those who use white lead much more careful in the manipulation of it. The debate in the French Legislature drags on from year to year, but until now social customs, economic reasons, and business interests have prevented the passing into law of the compulsory prohibition of white lead in house painting.

Preventive Measures.

The regulations issued by the Home Office are equal, if not superior, to those issued by the labour department of any other country. The main thing is to insist upon the regulations being carried out. Medical inspection of lead workers at short but regular intervals, with power of suspension, is of great importance in the prevention of industrial lead poisoning.

Workers frequently absent themselves so as to shirk the examination. Casual labour should be discouraged as much as possible. Alternation of employment in the works is most desirable. As the principal enemy is dust, wet methods should be substituted, so far as is practicable, for dry, and the ventilation of the various departments should be as free as possible. Measures, too, should be taken to remove all fume. The workers themselves must be careful not to create dust, they should take no food into the factory, chew no tobacco therein, and never eat without washing the hands. Warm baths, at least once a week, ought to be taken. A special suit of clothes or overalls should be worn in the factory, and washed once a week. The men should be told of the dangers and disadvantages of the intemperate use of alcohol, and encouraged to adopt abstinence.

When symptoms of lead poisoning develop, the workman ought to consult a doctor. Although no absolute reliance can be placed upon the preventive influence of the acid drinks formerly much in use in white lead works it is, on the whole, a good thing for the workman to take Epsom salts occasionally in the morning, or one or two of the sulphur lozenges, which Sir Alfred Garrod introduced. Sulphur is a preventive to some extent. Men ought to breakfast before going to work. For lead colic and paralysis, medical advice must be taken. The removal of lead from the system by means of electricity is now known to be possible of accomplishment.

Phosphorus and Lucifer Match Manufacture.

There are two kinds of phosphorus:—(1) The white or yellow, discovered by Brandt, of Hamburg in 1609, and (2) the red discovered by Schröter of Vienna in 1845. It is the white or yellow phosphorus that is the dangerous substance. From it, until recently, all the ordinary or "strike anywhere" matches were made. Yellow phosphorus has to be kept in water as it is extremely inflammable. It is also extremely poisonous. The red or amorphous phosphorus can be handled with impunity. It does not ignite when rubbed on a rough or smooth surface unless under unusual circumstances. Red phosphorus is non-volatile, and is, comparatively speaking, non-poisonous. One to three grains of yellow phosphorus will cause death, but fairly large doses of red phosphorus can be taken without any serious consequences. It is from the red phosphorus that the Swedish or safety matches are made.

The manufacture of lucifer matches is an important industry. In the 22 match works in Great Britain there were recently employed 4,000 persons, of whom three-fourths were females. Ten years ago public interest was aroused through the publication in the Press of the death of a lucifer match maker, and the announcement in the daily papers of several other workers being ill from a diseased condition of the jaw-bone, known as "phosphorus necrosis" or "phossy jaw." These circumstances created for the industry an unenviable notoriety, and led the Home Office to appoint a small committee, composed of Professor T. Thorpe, of the Government Laboratory, and myself, in conjunction with Dr. Geo. Cunningham, to enquire into the subject and to report upon the dangers incidental to the use of white phosphorus and the practicability of discontinuing the use of white or yellow phosphorus. The result of that enquiry was published as a Blue-book.

The malady of the lucifer match maker that is dreaded most of all, is "phosphorus necrosis"—a localised inflammation of the jawbones, which is extremely painful in its inception, requiring the removal of one or two teeth, followed by slow suppuration of the bone, and ultimately by the throwing off of the diseased bone as a *sequestrum* in many cases. The separation of the bone is a slow process, often requiring months or years, and during all this period, pus keeps trickling into the mouth, mixing with the food, and being swallowed along with it. The purulent discharge may descend the æsophagus and interfere with digestion, or enter the trachea and induce broncho-pneumonia. When the disease affects the upper jaw, it may by extension reach the base of the skull and set up septic meningitis, which is invariably fatal.

French physicians describe a form of constitutional disturbance met with in lucifer match makers to which the term "phosphorisme" has been applied. The malady which is accompanied by anæmia and the presence of albumen in the urine, by dyspepsia, the exhalation of a garlicky odour in the breath, and by a tendency to bronchitis, is practically unknown in this country.

Another malady to which lucifer match makers is liable, especially dippers, is fracture of the long bones. The fragility of the bones is such that in lifting the leg from the road-

way on to the pavement the thighbone sometimes snaps in two. Dr. Kocher, of Berne, states that fracture of the long bones occurred under such easy circumstances as those already detailed, five times in the same individual. Usually the patient has previously been the subject of phosphorus necrosis of the jaw.

Origin of the Lucifer Match.

The origin of the lucifer match is shrouded in obscurity. Like many other discoveries, several inventors were working in the same direction at the same time. It has been claimed that Stockton-on-Tees is the origin of the manufacture. On the other hand, Stephen Romer, a merchant in Vienna, is credited with having made the first matches, while others award the honour to France. There is not the least doubt that it was in Austria that the manufacture of matches was first carried out on a large scale. Vienna, for a considerable period, was the principal centre of the match industry in Europe. In 1831, Charles Sauria, a medical student of the College at Arc, in Dôle, demonstrated that matches could be made from a mixture of phosphorus, sulphur, and potassium chlorate. Sauria, who was a poor man, confided the secret to his teacher of physics, Professor Nicolet, who conveyed the information to Kammerer, of Wurtemberg, and he it was who started the first match works in Germany.

That is the story of the manufacture of lucifer matches as it affects Austria, Germany and France, but at an earlier date even than 1831 lucifer matches were being made and sold by John Walker, a chemist and druggist in Stockton-on-Tees. Walker, who was the son of a local grocer, studied chemistry. In April, 1827, he was making and selling matches fifty for one shilling. Two years afterwards, Mr. (subsequently Sir) Isaac Holden, M.P., without any knowledge of Walker's discovery, invented lucifer matches. To this country after all, and not to Austria, belongs the honour of this discovery. The boon conferred upon mankind by John Walker of Stockton-on-Tees can scarcely bo calculated.

Time will hardly permit of my doing more than making the briefest mention of the sesquisulphide of phosphorus lucifer. When invited by the Home Office to inspect match works at home and abroad, I visited works in France, Belgium, Sweden, and Prussia. At that time, France, like Great Britain, was trying to find a non-poisonous substitute for yellow phosphorus. I was present at Pantin-Aubervilliers, near Paris, when many of the experiments were being made. France ultimately solved the problem, for in the matches made by sesquisulphide of phosphorus we have lucifers that are non-poisonous, which strike anywhere, and the manufacture of which is unattended by risks to the health of the workers.

Another new form of red phosphorus has been invented from which matches can be produced that will strike anywhere, but time prevents me from making more than briefest mention of the compound.

The Chairman (Mr. H. H. Cunynghame) proposed a vote of thanks to Dr. Oliver for his interesting lecture, which was carried unanimously.

TENTH ORDINARY MEETING.

Wednesday, February 12th, 1908; Henry Graham Harris, M.Inst.C.E., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Devare, Harischandra Keroba, Lady Jamsetjee-road, Dadar, Bombay, India.
Hayne, Frederick William, 17, Cornwall-gardens, S.W.
Hughes, M. J., Warri, Southern Nigeria, West Africa.
Luard, Captain C. E., 20, Elm-tree-road, St. John's-wood, N.W.
McKinney, Hugh Giffen, M.R.C.S., Nafada, Northern Nigeria, West Africa.
Maxwell-Lefroy, Evelyn, Coromandel P.O., Southern India.
Powles, Henry H. P., 90, Oakley-street, Chelsea, S.W.
Tickner, Thomas Francis, F.R.I.B.A., High-street-chambers, Coventry, and Stoke-green, Coventry.

The following candidates were balloted for and duly elected members of the Society:—

Chowdhury, Manmatha Nath Ray, 18, Rawdon-street, Calcutta, and Santosh, District Mymensingh, India.
Matthews, Ernest Romney, F.R.S.E., A.M.Inst.C.E., F.G.S., Bridlington, Yorks.
Maung, Maung, 40, Phongyi-street, Rangoon, Burma.
Notley, Charles K., Honolulu, Territory of Hawaii,
Shepherd, James Whaley, A.M.I.Mech.E., care of The Carnatic Mills Co., Ltd., Madras, India.

The paper read was:—

THE APPLICATION OF SCIENCE TO FOUNDRY WORK.

By Robert Buchanan.

The founding of metals—that is, the formation of moulds made of refractory materials into which molten metal is poured—is not only a very ancient art, but it is of enormous importance to-day.

The ancients made castings of gold, silver, and bronze, all metals having comparatively low melting points. Their fuel and furnaces were inadequate to produce temperatures sufficient to liquefy the steel and wrought iron they made. These have been liquefied within a very recent period of time. The making of wrought iron and steel, and the casting of articles of bronze, were antecedent to the making of articles of cast iron by many hundreds of years. Some things the ancient worker in bronze had in common with the modern worker in cast iron. These are sand, clay, and straw, symbols of instability in all ages, and his principal care was the provision of suitable means of escape for still more unstable gases.

Were it not that wonderful things cease to cause wonder if they often recur, one would not cease to wonder at the fact that molten metals of high temperature and great fluidity may be confined within the well-defined limits of a mould through which gases pass freely. In certain cases the permeability of the mould by gases has to be so easy that if one cares to do so he may test the permeability by applying his mouth to the mould, causing his breath to penetrate it. This applies particularly to that part of a mould called a "core," and is often used as a test; yet such a core will refuse the penetration of molten iron. It may be noted here that this matter of penetrability of moulds by metals varies very considerably. I do not refer simply to the distance a molten metal will penetrate into a crack in the mould, but rather into the apparently solid surface of the mould. Lead penetrates more than brass, and brass more than iron. This penetrability is not a question of temperature, as the lead has the lowest melting point of the three and iron the highest. Probably the specific gravity of each metal has an effect upon penetrability of the mould, though objection may be made that the matter of specific gravity does not wholly supply the reason for greater or less penetrability.

Moulds for cast iron are of three kinds, if we exclude metal moulds for the production of chilled castings; and composite moulds, partly metal and partly sand, in which are made castings hard in parts and soft in parts. Rolls for use in iron and steel rolling mills are examples of castings produced in composite moulds of iron and sand. The hard, close-grained body of the roll is produced by the chilling effect of the iron mould, that is, the rapid abstraction of the heat from the molten iron. The softer neck of the roll is obtained by the slower cooling due to the slower absorption of heat by the sand mould at that part.

Excluding these, three kinds of moulds are used as stated. These are green-sand, dry-sand, and loam moulds. Clay is the material which in each of these forms the "bond," and the permissible quantity of clay is greatest in loam moulds and least in green-sand moulds.

Cores are mostly made from mixtures of sand and clay-water, but they are also made from mixtures of sand and resin, sand and dextrine, or "gum," sand and linseed oil, sand and flour, sand and molasses, or treacle; but the three last named mixtures are not much used in Great Britain.

The sand used with these latter substances as a bonding material is usually "sharp" sand—that is, sand practically free from clay, and thus has no cohesion of its own. Sand from the foundry floor, or burnt sand, or a mixture of these, is also used for this purpose. The advantages of using mixtures of this kind are as follows:—The cores are very hard when dried, and stand handling without chipping. They leave a good skin on the casting where the metal touches the core. They facilitate the easy fettling or dressing of castings containing them. Owing to the bonding material being driven off in the form of gas by the heat of the metal run into the mould, only the non-cohesive sand remains, and that is removed with very little trouble. In short, with these mixtures cohesion lasts as long as required, and ceases a short time after the metal surrounds the core, when cohesion is neither necessary nor desirable.

Green-sand moulds are so called because they are cast "green," that is, they are not dried previous to being cast. Dry-sand moulds are made from mixtures of sand which contain more clay than in the case of green-sand moulds, and a freer use of water is permissible without risk of defective castings, seeing the moisture is all evaporated by drying the mould in an oven. Thus during casting provision has not to be made for the passage through the mould of steam and water vapour,

as is necessary with green-sand moulds. Dry-sand moulds are more costly than green-sand, and are used when large quantities of metal have to be run into the mould, and exact contour of casting and conformity to the form of the model necessary. This exactness is possible owing to the mould being made hard and perfectly rigid as a result of the drying. Foundrymen often confound hardness with impermeability to the passage of gases through the mould. There is no necessary connection between hardness and impermeability by gases, and dry-sand and loam moulds are examples of hardness and permeability. In green-sand moulds, hardness and defective permeability by gases go together, as the mould has not only to allow free passage to the carbon monoxide generated by the heat of the molten iron, but has also to allow free passage for large volumes of steam and water vapour.

Loam moulds are employed when it is desired to obtain the casting with a minimum of cost for pattern-making. The materials for the mould consist principally of soft red bricks, with loam, a mixture of sharp sand and clay, as the binding materials. The loam is used of a similar consistency to that of the mortar used by a builder, and soft bricks are used in preference to hard, as they absorb moisture more readily, and thus admit of faster work being done. The loam also adheres better to soft bricks. As the clay in combination with the sand has lowered the fusion point of the mixture, care has to be taken that the iron does not form a silicate by fusing the mixture of sand and clay at all points of contact. Fusion of the sand is prevented by interposing betwixt the metal and the sand a coating of carbon. Carbon is absolutely infusible. In the case of green-sand moulds, a quantity of coal-dust made from bituminous coal is mixed with the sand. The hydro-carbons generated by the heat of the metal are absorbed by the surface of the casting, and give it the beautiful blue or greyish-blue colour desired in castings of best finish. With the South Staffordshire moulding sand this effect can be obtained without the surface coating of carbon and by means of the coal-dust alone mixed in the sand. This shows that South Staffordshire moulding sand has a high fusing point. I experimented with the object of ascertaining what it was that gave castings their particular colour of skin, and proved that the hydro-carbons from bituminous coal-dust gave the results desired in green-sand castings. I prepared two highly-polished pieces of iron, placed each on the top of a small clay crucible, and set each small crucible in a larger crucible, luting on the lid of the large crucible. In one small crucible was bituminous coal-dust, in the other anthracite coal-dust. The pieces of iron were not in contact with the coal-dust. The crucibles were fired in a muffle for 12 hours, with the result that the piece of iron over the anthracite showed no change; the other piece of iron showed the desired colour characteristics.

The carbon used to face the surface of green-sand moulds is wood charcoal made from one of the heavier woods, such as oak. In dry-sand and loam moulds, no coal-dust is used, and as the moulds are subjected to drying at a high temperature, the use of charcoal for the surface is not permissible. The carbon used for these is that obtained from gas retorts, ofttimes with an admixture of plumbago or "black-lead."

MOULDING SANDS.*

	Mansfield. Per cent.	Erith. Per cent.	South Staffordshire. Per cent.
Silica	94·02	87·86	93·40
Alumina	3·73	5·04	4·06
Oxide of iron	2·07	4·28	2·14
Lime	—	0·30	—
Loss on ignition	—	2·41	—
	99·82	99·89	99·60
Clayey matter removable by washing	4·70	—	4·90

COAL-DUST FOR MOULDS.

Sample dried at 100° C.

	Per cent.
Sulphur	0·973
Ash	10·470
Hydro-carbons	33·760
Fixed Carbon	54·797
	100·000

Moisture as received 6·05 per cent.

MELTING THE IRON.

A few foundries engaged in the production of special castings, such as rolls for rolling mills, use the reverberatory or "air furnace," but probably over ninety-nine per cent. of the castings produced in this country are cast from iron melted in the cupola furnace. In the "air furnace" only one quality of iron may be melted at one time, but with the cupola one may melt three or four qualities during an afternoon. In its simplest form, as seen

* Buchanan, "Engineering Magazine," Feb. 1903.

in many foundries to-day, the cupola is almost exactly the same furnace, so far as general arrangements are concerned, as that in which cast iron was first produced, or at least noticed, historically, about the beginning of the fifteenth century. At that time charcoal was the fuel employed. Now coke is invariably used, the coking of coal being first publicly accomplished about the year 1768 by Abraham Darby, of Coalbrookdale. There is, however, reason to believe that the coking of coal and the successful smelting of iron with it was accomplished by Dudley about the year 1621, but being used as a "secret" process, the secret died with him.

The cupola in its simplest form is a vertical cylinder lined with fire bricks, it has two or more openings for the entrance of the blast, an opening near the top through which the iron, coke, and limestone are charged, and a small hole about 1 inch in diameter at the bottom through which the molten iron is run.

The ease with which a competent cupolaman draws off any required quantity of molten iron is remarkable. He can measure out molten iron with as great facility as a milkman measures out milk.

If one examines the interior of a cupola in which iron has been melted a region of greatest wear will be observed. This is known as the "melting zone," and begins about 12 inches above the tuyeres where the blast enters, extends vertically for about 24 inches, and there terminates abruptly. This is the region of highest temperature, and it is at the top of the melting zone that the iron changes the solid for the fluid condition and trickles through the coke forming the bed to the hearth of the cupola. In a rapidly melting cupola the molten iron falls just as if it were so much rain. When charging the cupola preparatory to melting, a bed of coke, extending a foot or so above the top of the melting zone, is put in and kindled. Then a layer of iron is put on the bed, then another layer of coke with some limestone added, to flux the ash of the coke and sand adhering to the pig iron. On this is laid another layer of iron, and so on until the cupola is full up to the charging door. Melted iron first appears eight or nine minutes after the blast is put on. A regular, steady blast is very important, as it has been observed that blast of varying pressure has a marked effect upon the quality of the iron. High pressure of blast makes the iron harder, and low pressure makes it softer, so that if the iron is mixed to give a certain definite hardness, this may be nullified by a variable blast pressure.

Mixtures of Iron for the Cupola.

The mixing of iron on scientific principles is of very recent origin, but is being practised more and more by progressive, because better educated, foundrymen. Unfortunately, there exists in this, as in other countries, a large number of men in charge of foundries who, however skilled they may be in the ordinary routine work of a foundry, have not had the training, nor have they the knowledge, of how to apply chemical and metallurgical principles. This, for them, unfortunate position puts them into endless difficulties if they have to leave the beaten track of "use and wont." Where special strength or hardness or softness is required, they have to depend on brands of iron which in the course of years have obtained a reputation for the particular quality desired. They are not aware that the particular qualities of an iron depend upon its chemical constitution, and that no make of pig-iron is always of the same quality. Indeed, some pig-irons which have the same brand as they had twenty years ago are now made from quite different ores. Hematite iron, usually considered by foundrymen as the purest iron they can use, is often worse than ordinary pig-iron in respect of sulphur. These have been rejected by steel makers on that very account, and are passed on to the ironfounder of a larger faith in continuity of quality.

Such things would not be possible were iron foundries generally run on strictly scientific lines, as are all steel works and most blast furnaces. The blast furnacemen themselves buy iron ores and coke, subject to suitable analyses, but most of them have a marked disinclination to sell their iron to analysis. They prefer selling their iron by the well-known system of numbers—1, 2, 3, and so on—but no one has yet defined what any one of these numbers is meant to convey. In the whole domain of metals there is nothing so unscientific as this system of selling and buying pig-iron by numbers. The blast furnacemen have objected that, did they sell to analysis, most foundrymen would not know how to use the iron when they got it. That is perfectly true of many foundrymen at the present time, but were they confronted with the difficulty, of which unfortunately there is no immediate probability, they would perforce have to study the metallurgy of cast iron with

the greatest possible resulting benefit to themselves, and to the industry in which they are engaged. At the present time, only the very large firms, whose volume of business must be secured, are enabled to buy to an analysis. Once these firms have used analysis in the purchase and use of their foundry materials, nothing would induce them to revert to old methods of purchase and of use which are haphazard in the extreme. In a word, foundries using scientific methods of work find that they pay handsomely.

Before a foundryman can use scientific methods in his work, it is obvious that he must have some training in, at least, elementary chemistry and metallurgy. I have heard a very successful teacher of metallurgy say recently, that the number of foundrymen attending the classes had increased largely within the last two years. This is a most encouraging fact for those interested in the advance of the industry.

When one begins to apply scientific principles to the mixing of iron in the cupola, a profound knowledge of the metallurgy of cast iron is not necessary. A knowledge of the principles governing combustion, the function of fluxes, such as limestone, to form suitable slags, and the influence of the various constituents of cast iron so far as they affect the general body, will do for a beginning. I have heard it said that a certain noted metallurgist, after making over three thousand tests with iron containing varying proportions of carbon, stated that he did not know anything about the influence of carbon on iron.

In the case of cast iron we have not only carbon to consider, but also silicon, phosphorus, sulphur and manganese. These may naturally be thought to complicate and render more difficult the study of this metal. Let us consider the influence of each of these elements and see how they affect the metal, and how each may be made subservient to the founder. Each of the elements named may be helpful to him under one set of conditions and hurtful under other conditions. The iron-founder, employing scientific principles, uses only those which serve his purpose. Before he can do so he must understand what they are going to do for him, favourably or adversely, when he has in view the production of a particular quality of iron. By doing so, he puts aside all questions of brands and numbers of pig irons, and forms his new compound in exactly the same way as the chemist dces his. Each deals with elementary substances which combine in certain definite proportions. Beyond this, however, the ironfounder has to consider the changes which take place in melting the iron, and also the influence which size of casting has upon the ultimate product, owing to fast or slow cooling.

Carbon.

The amount of carbon present in cast iron, as well as the condition as graphite, or combined carbon, in which it exists in the iron, is almost wholly controlled by the other constituents present. When silicon is in excess, say $4\frac{1}{2}$ to 5 per cent., then the total carbon is usually under 3 per cent., and what carbon there is, is almost wholly in the graphitic form. When the total carbon is low in amount, the iron, though soft, tends to "sink" or draw in local heavy parts. When graphitic carbon is formed as the metal cools it evidently occupies a greater space as a flake of graphite than it did as a constituent of the compound carbon forms when existing as combined carbon. Thus, if the total carbon is low, the graphite flakes are fewer in number, the grains of iron accordingly pack more closely together, which is another way of stating that the contraction is greater. Castings with much graphite are termed "soft," because the flakes of graphite lying betwixt the grains of iron assist the parting of these asunder when the iron is machined or filed. Highly graphitic iron is weak as well as soft. Each particle of graphite weakens the general body, and when the particles are numerous they readily assist to form lines of fracture.

In many pig-irons and heavy sections of castings the graphite is quite visible to the unaided eye, and does, in fact, give grey iron its grey appearance. Combined carbon and graphitic carbon may be made practically interchangeable under suitable conditions. The presence of sulphur, the absence of silicon, or quick cooling of the metal will each or all of them cause the greater part of the carbon to take the combined form. Low sulphur, with silicon present to the extent of $3\frac{1}{2}$ to 4 per cent., with slow cooling, will cause almost the whole of the carbon to take the graphitic form. Grey iron has the greater part of the carbon existing as graphite, mottled iron has the carbon fairly well divided betwixt graphite and combined carbon, and white iron has the carbon almost wholly in the combined form. Each of these appearances is due to the chemical constitution of the metal plus the rate at which the

metal has cooled. As combined carbon increases, so does the hardness increase, and so also the strength increases up to a certain point, maximum general strength being reached when combined carbon of about 0·6 per cent. is present. With smaller percentages than 0·6 per cent. the iron is softer, is more flexible, and has a lower breaking strength.

The combined carbon in small castings is almost always greater in amount than in large castings, and this is due to the quick cooling of the small castings. This quick cooling of small castings readily causes the combined carbon to be in such excess as to make the casting appreciably hard, and sometimes chilled in parts. This is neutralised by increasing the silicon, and so increasing the expellent effect silicon has upon carbon, and as a first effect making it assume the graphitic form. The graphitic form, as we have seen, means softness.

Silicon.

The influence which silicon has upon the quality of cast iron was wholly misunderstood until Professor Turner made his memorable investigations and experiments. Up to that time silicon was believed to be a hardening agent at all percentages, but now we know that it begins to harden iron only when 4 per cent. and over is present. With less than 4 per cent. silicon acts wholly as a softener. It does so by causing the carbon to take the graphitic form as already mentioned. It is not absolutely true that silicon and sulphur exclude one another, though it is seldom one finds high sulphur and high silicon together in the same iron.

Hudson has shown that in "glazed" iron containing 4 to 5 per cent. of silicon the "glazing" is due to an appreciable quantity of sulphur present. One important effect silicon has is that of lowering the solubility of iron for carbon.

There is reason to believe that no free silicon is present in iron in the same way that carbon exists as graphite.

One important function silicon performs is that of increasing the solubility of iron for gases. There are gases present in all melted metals, and trouble ensues if the melted metal, when cooling down, begins to expel these gases, and so porous castings, or if it be steel, porous ingots, result. Silicon assists the retention of these gases until the metal has set, and so porousness is largely avoided. Silicon and aluminium have a very similar action in keeping the gases dissolved in the metal. Silicon has the advantage over aluminium in so far as it may be bought in the pig-iron up to 5 or $5\frac{1}{2}$ per cent., without any increase of price. In fact, these high silicon irons may sometimes be bought cheaper than iron with a normal quantity of silicon.

Manganese.

Manganese has the effect of hardening cast iron, but in ordinary grey irons I have seldom observed that to be the case, even when manganese reaches $1\frac{3}{4}$ per cent. Scotch pig-irons have a reputation for their capacity to carry scrap without hardening, and Scotch irons are usually high in manganese. The sulphur present in iron is largely rendered inert or neutralised if other irons containing appreciable quantities of manganese be added to the mixture. The manganese and sulphur combine as manganese sulphide, MnS., and this passes largely into the slag. Any manganese sulphide which remains mechanically mixed throughout the iron, is said, by Stead, not to harden the iron. Considered from this point of view, manganese is a softener of iron, seeing it removes sulphur which would otherwise undoubtedly harden it. Manganese increases the absorbing power of iron for carbon, and in this respect has an opposite effect to silicon, which, as we have seen, lowers the power of iron to dissolve carbon. That manganese increases the carbon dissolved in iron, is proved by the fact that ferro-manganese which contains 80 per cent. or thereabout of manganese, contains from 6 to 7 per cent. of carbon, as against 4 per cent. or so in grey cast iron. It is to be noted that the effect of manganese towards increasing the power of iron to dissolve carbon is not so great as the influence of silicon in the opposite direction. Silicon-spiegel is an iron containing notable quantities of silicon and manganese, and is used to make steel castings free from honeycombing. Holgate gives an analysis of this iron containing silicon 15·94 per cent., manganese 24·36 per cent., and total carbon only 1·20 per cent. The function of silicon-spiegel in improving the quality of steel castings consists in the silicon keeping the gases in solution, and the manganese, having a great affinity for oxygen, combines with the oxides interspersed throughout the mass of metal, and goes into the slag as oxide of manganese.

Irons containing manganese are less likely to have the carbon and silicon oxidised during melting in the cupola. Manganese is more

readily oxidised than iron, silicon, or carbon, and in this way manganese is distinctly beneficial.

Phosphorus.

Phosphorus plays an important part in the melting, casting, and in the structure of cast iron.

Phosphorus is present in all cast irons, except in the case of hematites, and it is not always absent from them. Up to 1·70 per cent. the phosphorus is combined with iron, conforming to the formula, Fe_3P, or phosphide of iron, this being the phosphorus eutectic or mixture of phosphorus and iron having the lowest melting point. Phosphide of iron has a most marked influence on the rapidity of melting, and also on the cost of melting. Turner says that when melting iron it it probable that sulphide of iron is the first compound to melt. Even if that were so, seeing that iron when charged into a cupola should not contain more than 0·06 per cent. sulphur, the influence of the sulphide towards lowering the melting point of the whole mass of iron cannot be very marked. There is very little difference betwixt the sulphur contents of hematite and ordinary grey irons, but there is a very marked difference betwixt the temperatures at which they are melted, and that difference is undoubtedly due to the higher percentages of phosphorus in grey irons lowering the melting point. That phosphide of iron has a low melting point, and that it melts *within the iron* before the mass of iron has given any pronounced sign of fusion was proved by Stead.

This phosphide of iron then by becoming readily fluid assists very materially the fusion of the iron as a whole, and lowers the the melting point of the whole. The melting point of a compound or alloy is almost always lower than the mean of the melting points of the individual constituents. Let us consider what takes place when melting hematite iron. There being no phosphide of iron and not much sulphide of iron present to melt at low temperatures, the heat of the cupola has to go on increasing until the silicon and carbon compounds melt at perhaps 250° C. higher than when melting a phosphoretic iron. It will thus be seen that phosphoretic irons may be melted with a coke consumption that would be quite impossible were hematite irons concerned. No credit then is due to one who melts these irons cheaper than another does when melting hematites or low phosphorus irons. Nor does any discredit attach to the higher coke consumption of one melting the latter. The melting point of each class of iron is fixed as we have seen by the presence or absence of compounds having low melting points, and of these phosphide of iron is the most important. Phosphoretic irons run fluid and castings made from these take on a nice smooth skin. The fluidity arises from the phosphide of iron having a low melting point, and the smooth skin arises from the the iron not having an erosive or "searching" action on the mould. This is owing to the phosphoretic iron being fluid at a temperature at which which a non-phosphoretic iron would be, if not solid, pasty. Unfortunately phosphoretic irons do not continue their beneficence further than in the melting and casting. Castings containing from $1\frac{1}{4}$ to $1\frac{1}{2}$ per cent. of phosphorus do not readily resist shock, and such percentages have a very weakening effect in general. If breakages are in excess of what they ought to be, then look to the phosphorus. For highest strength have phosphorus 0·20 to 0·40. For fluidity combined with strength have phosphorus 0·70 to 0·90. For fluidity with fair strength, you may go to 1 per cent., or very slightly over.

Sulphur.

There is no constituent of iron which exceeds sulphur in its active influence. That influence is unfortunately almost wholly not beneficial under ordinary conditions. Hence the anxiety of ironmasters and foundrymen to have the sulphur as low as possible. A high temperature in the blast furnace gives the conditions which are favourable for the production of an iron having high silicon and low sulphur. If through accident or bad management the temperature of the blast furnace be allowed to fall, then a large percentage of the sulphur passes into the iron. If the blast furnace remained at a high temperature almost the whole of the sulphur would go into the slag and remain there, which is, in fact, the normal condition of things. Occasionally, however, the foundryman gets iron which ought never to be sent out, and in an iron of reputation I have found as much as 0·13 per cent. At the very worst it ought not to have been over 0·06 per cent. Even hematites occasionally reach 0·20 per cent., and are probably irons which were intended for acid Bessemer steel making, but being too high in sulphur for that purpose, were sent to the foundry. These facts show that neither irons of reputation nor irons

supposedly pure are to be accepted as being consistently always of one quality, and that the best. Their producers would not be like the rest of the world if they never made mistakes. It is the business of the foundryman to see that the results of such mistakes are not passed on to him. The sole and only way by which the foundryman can protect himself is to buy by analysis, and to see that he gets the quality he wants and intends paying for.

Sulphur then requires strict watching for the following reasons. It is present in the iron as sulphide of iron, FeS, and has a very marked influence on the carbon, by making it take the combined form, and combined carbon means hardness. Sulphur also increases the contraction of iron, and greater contraction gives greater liability to fracture when cooling. Sulphide of iron has also the fatal quality that it gives out gases, as it and the iron containing it fall in temperature towards the setting or freezing point, and so cause unsoundness.

There are two, or perhaps three, ways of dealing with sulphur. The first and best way is not to put it into the cupola, and in this direction a close watch has to be kept on the contents of sulphur in the coke. However, there must always be some sulphur in both iron and coke, and its influence may be considerably lessened by the use of pig-iron containing manganese, as already explained, the manganese conbining with some of the sulphide to form manganese sulphide. Blast furnace men are able to use a coke containing $1\frac{1}{2}$ per cent. sulphur, and yet have only 0·03 per cent. in the iron, but that is by the use of large quantities of limestone. This is not permissible to foundrymen, as they work with very much lower temperatures, and highly basic slags are viscous, not fluid, at cupola temperatures.

The foundryman then has very limited power to lessen the effects of sulphur. In the ways indicated, and by the use of high temperatnres available to him, and so increasing to the highest degree the affinity of the slag for sulphur, and by melting hot metal, he practically exhausts the means at his disposal to counteract the evil effects of sulphur. Fluxes which have not lime as one of the components may make a fluid slag, but they have no power to lower the percentage of sulphur in the iron by carrying it into the slag. Such an influence is reserved only for fluxes containing lime, and a lowering of sulphur is best accomplished by a flux made from a mixture of limestone and fluorspar.

Having thus considered in some measure the constituents of cast iron and the particular influence which each exerts upon the general body, we now proceed to ascertain to what degree they are affected during the melting of the iron. This is necessary to be known before we can predict what the constitution of the iron in the casting will be. To be able to predict what the constitution of the casting will be, and be able to make one's predictions come true, are only possible when using scientific methods in mixing the iron.

When melting iron in the cupola, the constituents are altered as follows each time the iron is melted, the sulphur in the coke being taken as 0·70 per cent. :—

Sulphur	gains 0·038 per cent.
Manganese	loses 0·100 ,,
Silicon	loses 0·250 ,,
Phosphorus	unchanged.

Knowing the analyses of the various irons which it is proposed to use in the mixture, adding together each constituent, and adding or subtracting each gain or loss made during melting, one gets wonderfully accurate results. The following mixture for light castings (see p. 325), which will also be strong and soft, shows the method used.

Thermit Limited have put into the hands of ironfounders various compounds for use in emergencies, or for obtaining very special mixtures of metals. Thermit is a mixture of an oxide of iron, nickel, titanium or other metal, with aluminium in a finely-divided condition. Once combustion begins, an exceedingly high temperature is obtained without other heat than that obtained from the oxidation of the aluminium. The aluminium obtains the oxygen from the metallic oxide with which it is intermixed, and sets free the metal. The aluminium having become oxidised goes into the slag and floats on the top of the pure metal which has been produced. The Thermit process, however, can only have a limited use in ironfoundries. If from any cause a large ladle of iron has been allowed to get "dull," that is, has cooled sufficiently to be in a sluggishly fluid condition, then Thermit will be advantageous for the recovery of the necessary fluidity. Or if one desires to obtain special alloys of iron and nickel, or iron with definite percentages of titanium, or other rarer metals, the Thermit process readily provides the means of doing so.

A method of making castings in permanent iron moulds without chilling the iron has recently been introduced by Dr. Charles Szekely. The chilling is prevented by coating the iron mould with a compound of which steatite or French chalk is one of the components. The bottom of the mould is a fixture, two sides are put into and held in position by adjustable screws. The front and back sections are held in position by adjustable studs in the hinged top of the mould. All the meeting surfaces are planed, and vent holes through the iron mould are provided wherever cores require exits for the gases generated when the iron is run into the mould. As is the case with all moulds where there is to be direct contact of solid and liquid iron, the iron mould gets a preliminary heating. This is really making certain that no moisture is present on the surface of the mould. To bring liquid iron into contact with damp cast iron, or *vice versâ*, is about as safe as to play with gunpowder. The moisture which has condensed on a cold, iron mould, is instantaneously converted into steam by the molten iron, and an explosion results. I have been present when three tons of molten iron were exploded into the air by a similar cause.

The Szekely process of casting requires to be carried on in foundries where melting is continuous throughout the day.

It may be noted that it is quite possible to work ordinary chill moulds so rapidly, that is, fill them with molten iron in such rapid succession, that the iron mould begins to give off gases at a temperature under that of a dull red heat. This results in the castings being spongy, though they were solid when the iron mould was at a lower temperature.

The Recording Pyrometer is now being used in some foundries engaged in the production of malleable castings. They are used in the annealing ovens for the purpose not only of recording the temperatures employed, but also to act as a tell-tale as to whether the firing is regular or no. The annealing of malleable castings is still very largely empiric, and not much advanced in knowledge or practice during the hundred years which have elapsed since Lucas patented the process. This result is almost wholly due to the "closeness" with which each malleable founder keeps secret the details of his operations. The silence which accompanies the manufacture of malleable castings would almost persuade one that the methods are secret, whereas the principles are well known. It is no secret that in no branch of the iron trade is systematised scientific study and experiment more necessary. At present the exponents of the art of malleable casting prefer to remain dumb, and they must therefore be left to welter in the chaos, out of which only the scientist can bring order.

This paper would be of inordinate length were I to treat of the use in the foundry of the microscope and of metallography as important adjuncts to analysis, whereby one can watch day by day whether the proper structure of the metal is being obtained, but time does not permit. I am glad to bear testimony to the fact that scientific methods are being more and more adopted in the foundries of this country, and more and more foundrymen are

Name of Iron Used.	Cwts. in charge	Silicon.	Total Silicon.	Phosphorus.	Total Phosphorus.	Sulphur.	Total Sulphur.	Manganese.	Total Manganese.
Priorfield No. 3	2	3·250	6·500	1·059	2·118	0·045	0·090	0·630	1·260
I X.L. No. 3	2	3·079	6·158	0·321	0·642	0·035	0·070	0·250	0·500
B.F.M. No. 3	2	2·753	5·506	1·260	2·520	0·050	0·100	0·600	1·200
Denby No. 3	1	3·033	3·033	1·549	1·549	0·019	0·019	0·337	0·337
Scrap	3	2·500	7·500	1·200	3·600	0·090	0·270	0·300	0·900
	10	÷ 10	28·697	÷ 10	10·429	÷ 10	0·549	÷ 10	4·197
			2·869		1·042		0·054		0·419
		deduct	·250			add	0·38	deduct	·100
			2·619				·092		·319

The figures 10 used in division are, of course, the number of cwts. in a charge of iron which goes into the cupola.

Analysis of the Castings.—Silicon 2·619 per cent.; phosphorus 1·042 per cent.; sulphur 0·092 per cent.; manganese 0 319 per cent.

to be found in the metallurgical classes of our technical schools. These two facts, conjoined with the further fact that we have the happiness in this country to possess the most able practical foundry workers to be found on the face of the globe, make one look to the future of this great industry, not only with hope but with confidence.

DISCUSSION.

Dr. SZEKELY gave some further information about his process, and illustrated its working by means of one of the moulds described in the paper. He also exhibited a casting made by it.

Mr. S. B. GOSLIN thought many of the facts the author had mentioned would be of very great service to all who were interested in the daily occupation of founding. His remarks, however, had been confined solely to the use of iron, nothing being said of copper, tin or zinc. As the author pointed out, the founder of the present day in this and other countries was not much better off than in olden times, because he had to deal with men who, although they might be steady and skilful at the cupola, were entirely devoid of any knowledge of the chemistry of metals, or the reasons why when metals were melted and put into moulds, they frequently produced unsatisfactory castings. It was most encouraging to hear, however, that so many young men, he supposed in the Midland counties especially, were studying the chemistry and the specific character of the metals with which they had to deal. He had experienced the difficulties the author had mentioned as arising from the classification of iron by numbers 1, 2, and 3. When an application was made to the iron master to give an analysis of the iron, he put the founder off with the evasive answer that he did not know anything about it. When he had complained of the No. 3 Carron iron, he had been told to try No. 1, which was satisfactory for one or two pourings, and then was as bad as No. 3. Exactly the same remark applied to other Scotch irons, and Staffordshire and Derby products. As the author had stated, one of the secrets of success in casting iron was that there should be sufficient silicon in the iron, as the French discovered years ago. He was sorry the author did not refer more to the question of fluxes, America being in that respect far in advance of this country, Germany, or France. At the present time he obtained his fluxes from the United States.

Mr. R. H. READ said that unfortunately foundrymen in London could not systematise their work in the way one might think it could be done from the author's remarks. The author had given the characteristics of different qualities of iron, such as good, bad, hard, and soft, but a special quality was needed for each casting required. It was impossible to generalise in London. There was no pipe foundry in London where nothing but pipes were made, and unfortunately foundries had to meet the requirements of all classes of customers. For instance, he had noticed that afternoon that in his own foundry there were such different articles as a steam cylinder, a builder's column, some ornamental railings, and some brake blocks for motorcars. It was impossible to have different kinds of pig-iron for such a variety of work, and the system his firm had adopted was to use the very best pig-iron even for castings which did not require such a high quality. Nine out of ten customers wanted the iron soft, and by using a pig which insured that requirement complaints were generally avoided. He used the best Scotch pig, and with the particular brand he was now using he had not received a complaint in four or five years. The character of the casting was determined also not only by the pig but by the scrap that was used. In the Midlands, four parts of pig to one part of scrap was generally used, but in London the proportions were practically reversed. The microphotographs the author had shown no doubt gave the true determination of the structure of the iron, but he did not think the method altogether did away with the old-fashioned method of believing one's own eyes. By breaking the iron it was possible to tell whether it was hard or soft, whatever number it was called. Naturally it was necessary to use soft scrap as well as soft pig if a soft casting was required, but for such articles as fire cheeks and fire bottoms for big cooking ranges, which owing to the fierce fires, burnt through very quickly, it was necessary to use the very commonest class of iron which had been burnt before, pig being useless for the purpose.

Mr. HUGH STANNUS said the author had referred to a difficulty connected with the escape pipe, which he noticed was not at the highest point of the receptacle. He suggested that if the receptacle had been domed, and the escape pipe had been at the top of the dome, there would be more chance for the heated gases to escape. The paper he thought could be summed up in the phrase that it was necessary to analyse the iron and keep an eye on the cooling. As he was born in Sheffield, and had the honour of sitting under Henry Sorby, one of the most clear-headed men who had ever honoured the British nation, he had been intensely interested in the series of slides shown. Large cutlery works in Sheffield kept their own analyst, because, as the chief partner of Thomas Turner and Co. had said to him, they liked to know what went into their knives. It was the application of science to the alloying of the metal which had made the name of Turner in the cutlery world. He thought it might be worth the while of some public chemist in London to conduct similar analyses of metals. Architects at present simply analysed iron by breaking it, treating it with

acid, and looking at it with a lens; but it would be possible to find out much more clearly what was in the metal by means of a thorough analytical test, such as was made by Kircaldy. Personally he had had more to do with the application of art to metal work, but that did not preclude the application of science to the same subject; and he thought the paper would materially conduce to that application.

Mr. F. W. HARBORD said he had been particularly struck by the author's statement that, by the aid of the microscope, he was practically able to control his iron. The microscope had been used similarly in regard to steel, but it had not arrived at the same state of perfection. In 99 cases out of 100 the problem of a foundryman consisted in finding a method of maintaining a soft iron, and that could be done by regulating the percentage of silicon in the iron. In most foundries, at all events in the Midlands and the North, it was the practice to use glazed pig-iron, or high silicon pig-iron, and when the brands and the scrap were stronger than usual, to add a larger amount of glazed iron, thus maintaining in the finished product a regular iron containing a percentage of silicon which was found to give the best results from that particular practice. In most cases an iron was required which would give the greatest maximum stress combined with maximum softness, two rather antagonistic requirements, but they could be obtained by adding silicon. In London practice, foundries which used a large quantity of burnt scrap could, by using a comparatively large quantity of high silicon pig, restore it to the required degree of softness. It would be of interest if the author would state whether the high ferro-silicons, which were being used largely in steel foundry practice, were also being used in iron foundry practice.

The CHAIRMAN, in moving a hearty vote of thanks to Mr. Buchanan for his extremely interesting paper, thought a paper on such a subject ought not to be allowed to pass without mention being made of the name of Roberts-Austen, who was connected with the Society for many years, having served for two successive terms as a member of the Council. He was the chemist of the Mint; and no living man in his time did more for the science of metallurgy in the way of rendering it popularly understood. He was a most lovable man, in addition to being one of the ablest and most brilliant intellects that he ever met. He was probably the first to point out the effect of infinitesimal variations in the composition of certain constituents of metals, and also the effect of phosphorus. Roberts-Austen was also the originator of that somewhat memorable address of his (the Chairman's) late partner, Sir Frederick Bramwell, when he was President of the British Association, on "The next to nothing," where Sir Frederick pointed out how, in the industrial and scientific world, the next-to-nothing was of infinite importance in the effect it had on the resultant product. When Dr. Szekely's work was first brought to his notice some five or six months ago, he (the Chairman) thought he knew something about casting and cast iron, having from his earliest days been connected with cast iron and other metals; but when he was told by Dr. Szekely's representative that, in an iron mould, he produced in less than a minute a motor-car cylinder or a pair of cylinders, and from any ordinary metal which was used in London foundries a casting which could be easily machined, and which was practically without contraction or expansion, *i.e.*, when cooled fitted the mould exactly, he was inclined to laugh. But he had seen that done, not only with motor-car cylinders, but with a good many other things. He did not know why it was possible; but it had upset one of the ideas which was firmly secured in his mind as to what it was possible and impossible to do with castings. Aluminium was a much more difficult metal to cast than iron, from the point of view of shrinkage and expansion, and yet Dr. Szekely had informed him that he was able to do the same with aluminium in an iron mould as he did with cast iron. The author had shown a Chinese cupola, and belauded it by saying that more satisfactory metal could be produced from it than any other cupola he knew. If, in his reply, the author gave some slight indication of his reason for that assertion, he thought it would be of interest to the meeting.

The vote of thanks having been carried unanimously,

Mr. BUCHANAN, in reply, said he was sorry he had led the Chairman to believe that the Chinese cupola was better than any other, because he was simply speaking of cupolas in general, and not of any one in particular. With a cupola of 19 cubic feet capacity from the bottom of the charging door, he had melted more than 1 cwt. of iron per hour per cubic foot. One explanation of the fact was that the larger the cupola the less metal it would melt per cubic foot. In the small cupola the coke was in direct contact with the air, and the combustion was more rapid. By using good coke and a properly proportioned blast, those results might be obtained by anyone who mixed a little brains with his practice. In reply to Mr. Goslin, he did not profess to be an authority on the founding of copper, zinc, and tin, one metal usually being sufficient for one man to specialise in. He also desired to correct Mr. Goslin's statement that the French discovered the influence of silicon on iron, Professor Turner, of Birmingham, being the first to make that discovery. On the general question of the education of foundrymen, he desired to mention that there was a body called the British Fonndrymen's Association, of which he had the honour to be the first President. The members of that Association hoped to educate each other so that they would become better foundrymen, and in that way better citizens of this country. There was a patriotic

motive at the back of the Association, and it hoped before long to make the foundry industry in this country what it ought to be. Mr. Goslin had also referred to American fluxes. He remembered reading about seven years ago that a smart American was going round the country selling a patent flux, which another smart American discovered was slag from the blast furnace. Fluxes of that kind were not required in this country, but if Mr. Goslin wanted them he could introduce him to people in South Staffordshire who would be glad to let him take them away. The difficulty Mr. Read mentioned of the great variety of castings was undoubtedly an important one, but a man who wanted a soft cylinder evidently did not know what was good for him. Mr. Read had also stated that it was possible to tell by breaking the iron whether it was hard or soft. If a blast furnaceman ran a certain pig-iron out of his furnace, covered it up with sand, and allowed it to cool very slowly, would Mr. Read be able to say what number pig it was? If the blast furnaceman cooled it quickly with no sand on the top it was called No. 3; if sand was put on the top and it was allowed to cool slowly it was called No. 1. Reference had been made to Dr. Sorby. He saw some of Dr. Sorby's original sections in the Sheffield University a few months ago, and looked upon them with the greatest possible reverence as the first beginnings of a great advance in metallurgy. In reply to Mr. Harbord, it was impossible to control the iron by means of the microscope, it only being possible to tell by it whether the original structure which ought to be obtained was being maintained, and that could be done with a given section of casting. There was no use, however, changing from a thin section to a thick one, because the same structure would not be obtained; but if castings were being run which were soft and fairly tough, then it was possible to tell whether the iron was keeping regular or not. He knew one foundry which was using high ferro-silicon iron. Close-grained iron, hard and low in silicon, was being run, but when a particularly thin casting was made which had to be machined, some high ferro-silicon iron was put into the ladle, thus softening that particular lot of metal for the casting. He entirely agreed with the Chairman's remarks about Roberts-Austen, whose name was a household word in England. He hoped his paper would stir up foundrymen to be open with what they were doing. If that principle were adopted it would be more helpful than hurtful, because it was only by having confidence in one another and assisting the industry that it would reach the high standard they desired it should attain.

ARTS AND CRAFTS.

Embossed Wall Coverings.—Embossed wall decorations of various kinds have, within comparatively recent years, become a matter for the serious consideration of those practically concerned in decoration. And yet, when we come to consider the question, the wonder is not so much that such wall coverings are relatively common, but that they are not much more generally used than they are. For it must be admitted that relief does certainly add considerably to the richness of a wall decoration. Moreover, in the passion for the old which, in spite of all our modernism is very evidently still with us, it is rather surprising that people have not fallen captive to a form of decoration so fascinating as the painted and embossed leathers without which no French house, at least of any importance, was considered properly furnished in the seventeenth and early eighteenth centuries. No doubt, embossed wall coverings are comparatively expensive, and unfortunately the fact that they will wear for a very long time does not, in these days when everyone is eager for constant change, weigh quite as much as it might have done a century or so ago. Again, some of the embossed materials have not generally been used to the best advantage, and have been made to look quite unnecessarily mechanical and unattractive. There is some reason for the fact that most of us naturally and almost inevitably associate one kind of embossed wall covering with railway carriages, and look upon another as a rather poor substitute for plaster ceilings. For all that, there are embossed materials, some of them very costly, others less expensive, which really make beautiful decoration of a sort which it would be quite impossible to get by means of any kind of flat wall covering—and it is really astonishing that this is not more generally recognised. Is it partly, perhaps, because the decorator is generally more anxious to recommend some process in which the lion's share of the profits goes to him and not to the wallpaper manufacturer? The different materials upon the market range from paper to metal. "Leather papers" have been made, as everyone knows, for a long while; it is less well known that here in England real leather is also occasionally used—embossed and lacquered like the old Spanish and Venetian material. This is obviously a very expensive form of decoration, but the qualities of surface, colour and effect are really fine. Who could forget the peacock pattern, by Mr. Walter Crane, reproduced in leather by Messrs. Jeffrey and Co.? It was a really magnificent production. Another ingenious idea of the same firm of paper-stainers is to produce their embossed patterns also in copper. This metal is most serviceable in places where a rich decoration is wanted and yet great demands will be made upon its wearing powers. The effect is precisely like *repoussé*—though the design is actually stamped in a press, with the result that the price is far less than would be the case if it had all been beaten by hand. The parts in high relief are filled in with a hard substance to prevent them from getting damaged by knocks and so forth, and the ground is sometimes dulled so as to contrast with, and relieve, the pattern.

Recently, the Anaglypta Company have had

the happy idea of using their material in a more precious kind of way than heretofore, and, with this end in view, have produced some very charming little panels, lacquered and silvered or bronzed, as the case may be, which are not only fit to be used in friezes and such like, but are worthy of being hung on the walls of a room more or less after the manner of reliefs or of pictures. These particular panels, which are designed by Mr. Gilbert Bayes, represent the four elements—Earth, Air, Fire and Water. They are very fanciful and pleasing designs; their colour, bluish green combined with bronze or silver, is very attractive, and their dull wooden framing is of the right kind of tone to throw up the gorgeousness of the colour without, in any way, interfering with it. These panels probably mark no advance in the technical perfection of Anaglypta. It is probably the first time that the ordinary outsider has had the chance of realising that he could acquire for a few shillings an adequate coloured representation in relief of the work of a distinguished sculptor; and the opportunity of getting panels in relief which are really fine in design, and can be used as points in a scheme of decoration seems too good to be lost. Original work of this kind is out of the reach of most people, much as they may desire it: it only remains to be thankful for what we can get, and remember that it is no slight matter that good reproductions of such things are to be obtained at moderate cost.

New Old Wedgwood.—Attention is naturally more quickly drawn to things which are absolutely new (or as near to that as anything ever is) than to those which are only reminiscences or reproductions of what has been done before. And yet, to get at the sum total of what is being done, this last class has to be included—and when we come to examine it, it is rather surprising to find what a very large class it is. Perhaps, in spite of all our boasted modernity, there never was a time when more work was being done on old lines or in direct imitation of the old, than at the present day. The thirst for Victorian, or pre-Victorian decoration seems to be insatiable, and it has brought along with it a demand for furniture and all kinds of accessories in keeping with it. This being so, it has, not unnaturally occurred to some of the old and well-known firms that here is, for them, a golden opportunity, and that they may as well make hay while the sun shines—it certainly will not shine continuously or for ever.

It has been natural, in considering what has recently been done in the way of pottery, to chronicle the new developments of the industry rather than the returns to the old ways; yet there has been a good deal of this returning going on quietly enough for some time past. Imitations and copies of old shapes and old processes have been produced by various makers and have in some cases found a very ready sale. Now we have a revival of the old Wedgwood tableware. The simple earthenware plates, and cups and dishes and teapots, &c., which were made generations ago by the firm, are being busily copied, and patterns on the same lines are being added to them. This is not, of course, the kind of ware to which we have grown almost to confine the name of Wedgwood—the celebrated Jasper ware; it is quite unlike that. The specimens shown at Whitefriars by Messrs. Powell, who have the sole rights of certain of the patterns, are ordinary earthenware cups, and so forth, decorated with simple patterns, generally floral, produced partly by printing and partly by painting. They are not great in any way, but the shapes for the most part are pleasing and refined, and they are thoroughly suggestive of the material in which they are made. It is rather refreshing, on the whole, to see a collection of simple, well-made earthenware decorated with such admirable simplicity. A few of the shapes and patterns have been copied in china, but the effect of these is far less satisfactory than that of the pieces reproduced in the homelier ware for which they were originally designed.

Camberwell School of Arts and Crafts.—Some practical people are rather inclined to complain of the present day schools of art that they are too much craft schools, and not enough of trade schools; and there seems to be a certain amount of reasonableness in the complaint. It is, however, hardly fair to grumble at a school which labels itself "School of Arts and Crafts" because it pays no particular heed to manufacture. Amongst the London schools which do so describe themselves the Camberwell School of Arts and Crafts is one of the most enterprising, and their annual exhibitions get increasingly interesting as the years go on. The level of accomplishment attained by the students varies considerably in the different classes, but some of the work shown reaches a point where it is really interesting—where the student has been able adequately to express his artistic idea through his craft. The embroidery exhibits were amongst the most numerous, and displayed a much more catholic taste than schools of art have accustomed us to expect from them. Not only is there a good show of the coarser kinds of needlework, but some of the students have attempted, very successfully, very fine gold thread work. Perhaps the most marked feature of the work, as a whole, is the use of cunning little surface diaperings, which occur in great variety, and are often employed with marked taste. The exhibition at Camberwell includes, amongst other things, examples of bookbinding, script, jewellery, and wood-carving. An interesting feature of the show was the collection of museum studies. It would seem that now-a-days the idea that studying in a museum spoils the individuality of the student, has somewhat exploded, and that studies made in the museum are again taking their place as a very necessary part of artistic training. Certainly there were a goodly number of them at Camberwell, and they have been more *en evidence* lately at other schools too.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

FEBRUARY 19.—"The Law of Treasure Trove." By WILLIAM MARTIN, M.A., LL.D.

FEBRUARY 26.—"The Problem of Road Construction, with a View to Present and Future Requirements." By PROF. H. S. HELE-SHAW, LL.D., F.R.S., and DOUGLAS MACKENZIE. The HON. RICHARD CLERE PARSONS will preside.

MARCH 4. — "Modern Dairy Practice." By LOUDON M. DOUGLAS.

MARCH 11.—"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By ERNEST R. MATTHEWS, F.R.S.E.

MARCH 18.—"Impressionist Painting: its Genesis and Development." By WYNFORD DEWHURST,

MARCH 25.—"Recent Improvements in Decorators' Materials." By A. S. JENNINGS.

APRIL 1.—"The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE.

APRIL 8.—"Technical Education in America." By SIR WILLIAM H. PREECE, K.C.B., F.R.S.

APRIL 29.—"Modern Roumania." By ALFRED STEAD, Consul-General for Roumania."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock :—

FEBRUARY 25. — "Irrigation in Egypt under British Direction." By SIR HANBURY BROWN, K.C.M.G. The EARL OF CROMER, O.M., G.C.B., G.C.M.G., K.C.S.I., will preside.

APPLIED ART SECTION.

Tuesday evening, at 8 o'clock :—

FEBRUARY 18.—"Banners in Pageantry." By GEORGE W. EVE. WALTER CRANE, R.W.S., will preside.

CANTOR LECTURES.

Monday evening, February 24, at 8 o'clock :—

HENRY HARDINGE CUNYNGHAME, C.B., "The Theory and Practice of Clock Making."

SHAW LECTURES ON INDUSTRIAL HYGIENE.

Friday evening at 8 o'clock :—

FEBRUARY 28.—"The Removal of Dust and Fumes in Factories." By DR. JOHN SCOTT HALDANE.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Henry Hardinge Cunynghame, "The Theory and Practice of Clock Making." (Lecture V.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Francis Fox, "Foundations: the Use of Divers, and the Grouting Machine."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. H. L. Orchard, "Philosophy and Evolution."

African Society, Criterion, Piccadilly, W., 8½ p.m. Lieut. Boyd Alexander, "From the Niger to the Nile."

TUESDAY, FEB. 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. G. W. Eve, "Banners in Pageantry."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Stirling, "Membranes: their Structure, Use, and Products." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W. 8 p.m. 1. Mr. J. J. Prest, "Shaft-Sinking at the Horden Colliery." 2. Mr. W. B. Parsons, "The New York Rapid-Transit Subway."

Statistical, 9. Adelphi-terrace, W.C , 5 p.m. Mr. Bernard Mallet, "A Method of Estimating Capital Wealth from the Estate Duty Statistics."

Zoological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, FEB. 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William Martin, "The Law of Treasure Trove."

Meteorological, 25, Great George-street, W., 7½ p.m. 1. Mr. C. Browett, "Snow Rollers." 2. Mr. E. Gold, "Comparison of Ship's Barometer readings with those deduced from Land Observations."

Microscopical, 20, Hanover-square, W., 8 p.m. Papers by Mr. E. M. Nelson, Rev. Eustace Tozer, Mr. F. Chapman, Exhibitions by Mr. C. L. Curtis and J. E. Bernard.

United Service Institution, Whitehall, S.W., 3 p.m. Lieut. J. W. Lewis, "Norwegian System of National Defence."

British Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, FEB. 20...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. Papers by Mr. Arthur W. Sutton, Dr. V. E. Shelford, Dr. A. T. Masterman.

Chemical, Burlington-house, W., 8½ p.m. Papers by Mr. G. Barger, Messrs. H. Hartley, N. P. Campbell, and R. H. Poole, Mr. G. T. Morgan and Miss F. M. G. Micklethwait, Mr. F. S. Kipping, Mr. N. L. Gebhard.

Junior Engineers, United Service Inst., Whitehall, S.W., 8 p.m. Mr. G. Whalley, "The Testing of Gas Engines."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Somerville, "Wood: its Botanical and Technical Aspects." (Lecture I.)

Optical, 20, Hanover-square, W., 8 p.m. Dr. R. T. Glazebrook, "Resolving Power and Definition in Optical Instruments."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. H. Henderson, "Electrical Power in Railway Goods Warehouses." 2. Mr. C. E. Taylor, "Electric Power in Docks."

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m. Annual Meeting.

Numismatic, 22, Albemarle-street, W., 6½ p m.

FRIDAY, FEB. 21...Royal Institution, Albemarle-street, W., 9 p m. Sir Oliver Lodge, "The Ether of Space."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. Gerald O. Case, "Currents as a Cause of Coast Erosion."

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. "The Mounting of a Play."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. E. Warren, "Oxford."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Prof. J. Goodman and Mr. D. B. MacLachlan, "Test of a Live Steam Feed-Water Heater."

SATURDAY, FEB. 22...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Selwyn Brinton, "The Art of Florence." (Lecture II.

Journal of the Royal Society of Arts

No. 2,883. VOL. LVI.

FRIDAY, FEBRUARY 21, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 24, 8 p.m. (Cantor Lecture.) H. H. CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." (Lecture VI.)

TUESDAY, FEBRUARY 25, 4.30 p.m. (Colonial Section.) SIR HANBURY BROWN, K.C.M.G., "Irrigation in Egypt under British Direction."

WEDNESDAY, FEBRUARY 26, 8 p.m. (Ordinary Meeting.) H. S. HELE-SHAW, LL.D., F.R.S., and DOUGLAS MACKENZIE, "The Problem of Road Construction, with a view to Present and Future Requirements."

FRIDAY, FEBRUARY 28, 8 p.m. (Shaw Lecture on Industrial Hygiene.) JOHN SCOTT HALDANE, M.D., F.R.S., "The Removal of Dust and Fumes in Factories."

Further details of the Society's meetings will be found at the end of this number.

COUNCIL.

At the last meeting of the Council on Monday, 17th inst., Sir William Bousfield, M.A., LL.D., was elected a Vice-President of the Society to fill the vacancy caused by the death of Lord Kelvin. Sir William Lee-Warner, K.C.S.I., Chairman of the Indian Section, was elected a Member of Council in place of Sir William Bousfield.

INDUSTRIAL HYGIENE.

The Council of the Royal Society of Arts, acting on the report of a committee of judges, have awarded the Gold Medal offered by the Society, under the Shaw Trust for Industrial Hygiene, to Professor William Galloway, "In recognition of his valuable researches into the action of coal dust in colliery explosions, the outcome of which researches has been the provision of means by which the risk of such accidents is materially diminished, and a consequent great saving of human life effected."

The Committee having also directed the attention of the Council to the device for "racing" or trueing up grindstones described in the *Journal* of the Society (30th August, 1907), by Messrs. S. R. Bennett and C. F. R. Johnston, the Council decided that this invention, which has for its object the prevention of dust in the process, is worthy of favourable commendation.

CANTOR LECTURES.

On Monday evening, 17th instant, Mr. HENRY HARDINGE CUNYNGHAME, C.B., delivered the fifth lecture of his course on "The Theory and Practice of Clock Making."

The lectures will be published in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday afternoon, February 18th; WALTER CRANE, R.W.S., in the chair.

The paper read was "Banners in Pageantry." By GEORGE W. EVE.

The paper and discussion will be published in a future number of the *Journal*.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

Tuesday afternoon, January 28th; The Right Hon. Sir Charles Wentworth Dilke, Bart., M.P., in the chair.

The paper read was:—

THE DEVELOPMENT OF COLONIAL SELF-GOVERNMENT IN THE NINETEENTH CENTURY.

By A. Berriedale Keith, M.A., B.C.L.

It may not be without interest at the present day, when the importance of the self-governing colonies has received full recognition from His Majesty's Government in the adoption of the title, Imperial Conference, in place of that of Colonial Conference, and when not only has His Majesty conferred upon New Zealand the status of a Dominion, but a special Dominions Department has been created in the Colonial Office, to trace in some detail the steps in the development of the autonomy of the self-governing colonies.

Representative Government: its Characteristics.

In the year 1840, when the history of self-government may fairly be said to make a new start, the great majority of the British colonies were in possession of the form of colonial government best known as representative. Under that system, the government of the colony was entrusted to a body of executive officers selected, as regards the occupants of the principal posts, by the Secretary of State, who then combined, under his control, the affairs of the War Department and those of the colonies. The Legislature, on the other hand, was a representative one, consisting of two Houses, of which the Lower was elected on a fairly liberal franchise, and the Upper was nominated by the Crown mainly on the advice of the Governor. Like the executive, the judiciary were nominees of the Secretary of State, but they held by a relatively permanent tenure, and were not, as a rule, particularly amenable to executive control, though in the main they were drawn from the same class as, and shared the general political and social opinions of, the high executive officers, so that their differences turned mainly on points of professional interest than on fundamental divergences of political conceptions.

It is clear that such a situation of affairs left wide ground for friction and dispute, and it is easy now to wonder how it could ever have been considered as other than a temporary form of political organisation. The wishes of the people, or rather of those classes which enjoyed political power, as expressed in the Legislature, were subject to the Governor's control through his nominees in the Upper House, and his negative voice in legislation. On the other hand, the Governor was helpless in money matters, for all taxation, except as regards the comparatively short civil list, was subject to the vote of the Legislature, and he thus had to spend his time in alternate attempts to bully and to cajole the Houses into agreement with his plans. But even if the Governor and the Legislature were at one on any issue, there was always the possibility, on some subjects it might be said the probability, of the Secretary of State refusing to accept the legislation when sent home for Her Majesty's sanction. It was then deemed essential to supervise in detail all colonial legislation and to disallow without hesitation any act which might offend against Downing-street's conceptions of prudence and expediency, although such legislation concerned none save purely local interests. It is perhaps only fair to Downing-street to say that the legislation which they thus peremptorily rejected was often of the most unscientific and even foolish description, and that their action in the vast majority of cases was conceived solely in the interest of the colony, though no doubt that interest might easily be misunderstood by men who had themselves no colonial experience and had to rely for their views of the general situation of affairs on the scanty and often biassed reports of the Governor for the time being who was seldom anxious to throw much light on his acts.

Its Defects.

It is clear that such a form of government tends to be in a state of unstable equilibrium and either to advance to the system now known as responsible government or to regress to Crown Colony administration. The examples of progress are so much the more interesting that it is not unnatural that they should be usually considered as the normal state of affairs. But as a matter of fact the instances of retrogression are quite as numerous. In 1840 representative government existed in

British Guiana, Jamaica, Grenada, Tobago, St. Vincent, Antigua, Dominica, St. Kitts, Nevis, Montserrat, Barbados, Bermuda, the Bahamas, and even in the tiny Virgin Islands. Financial difficulties, the impossibility of adjusting the relations of the executive to the Legislature in colonies where the vast majority of the people are not and cannot well be represented in the Legislature, and other causes have combined to reduce the number of representative government colonies, which have not also responsible institutions, and for which the Crown has no right of legislation by Order-in-Council, to three only—the Bahamas, Bermuda, and Barbados, British Guiana has in matters of finance representative government. In these cases the system, on the whole, works satisfactorily; the colonial legislatures are given as far as possible a free hand, and the Secretary of State merely interposes when financial considerations or the rights of minorities seem imperatively to demand it; but it is interesting to note that a certain approach to responsible government exists in the shape of the association of members of the Legislature with Government officials on the executive councils of Bermuda and the Bahamas, and in the institution of an executive committee in Barbados, on which sit members of the two houses of the legislature, together with the members of the executive council, and which initiates all money votes, prepares the estimates, and introduces Government business. But it is not likely that any further step can be taken. Bermuda is still an Imperial fortress, and both in Barbados and the Bahamas the Imperial Government is trustee for the interests of the comparatively large native population, so that these three colonies will probably remain interesting examples of an imperfect development. It is a mistake, however, to suppose that the course of development is naturally from Crown Colony government through representative institutions to responsible government. Historically the oldest form of colonial government is something much more nearly allied to representative government than to Crown Colony administration, and, leaving aside the cases of mere fortresses and commercial stations, the history of the Constitutional development of the colonies "by settlement" is one either of the enlargement of the powers of the popular assembly until it controls the whole executive government or of the voluntary surrender of its powers to the Crown in order that there may be instituted a strong executive authority; as was avowedly the case in the surrender by Jamaica of its representative government, after nearly two hundred years of existence, in 1866 consequent on the disturbances.

Lord Durham's Report.

But the cases of retrogression, numerous and interesting as they are, are of little consequence in comparison with those of progress. No doubt the idea of establishing in the colonies a system of government comparable with that of the Mother Country appears obvious enough, but it was not so in 1838, and the boldness and substantial originality of Lord Durham's report will ever secure him the renown of the founder of the system of responsible government. Much else in that famous document has been falsified by the march of time. It must be strange for a native of Quebec to read the confident prediction:—

"It will be acknowledged by everyone who has observed the progress of Anglo-Saxon colonisation in America, that sooner or later the English race is sure to predominate even numerically in Lower Canada, as they predominate already by their superior knowledge, energy, enterprise, and wealth. The error, therefore, to which the present contest must be attributed, is the vain endeavour to preserve a French Canadian nationality in the midst of Anglo-American Colonies and States."

Indeed, Lord Durham's great solution for the racial question, the amalgamation of Upper and Lower Canada, was decisively undone in 1867, when confederation took place, and for years before that date it had proved itself quite unworkable.

In these cases, however, Lord Durham was dealing with forces which are too strong for statesmanship, and merely made the error common enough in the days before nationalism had become the dominant principle which it now is, of underestimating the power of race feeling. The substantial correctness of his political training is shown in the fact that no single point of his exposition of the fundamental character of responsible government requires alteration to-day, after sixty-six years of actual experience of its working. In rejecting the proposed solution of the constitutional question by the expedient of an elected executive council—an idea which has analogies in the early history of English constitutional government—he wrote:—"Every purpose of popular control might be combined with every advantage of vesting the immediate choice of advisers in the Crown were the Colonial

Governor to be instructed to secure the co-operation of the Assembly in his policy by intrusting its administration to such men as could command a majority, and if he were given to understand that he need count on no aid from home in any difference with the Assembly that should not directly involve the relations between the Mother Country and the colony." No alteration in these principles has taken place since they were enunciated, and the history of the growth of the autonomy of the self-governing colonies consists merely in the further definition and limitation of the conception of what affects the relations between the Mother Country and the colonies, and in the gradual geographical extension of the principle of self-government. Conferred first on the United Province of Canada, it was extended by 1850 to Nova Scotia, New Brunswick, and to Prince Edward Island, and in 1855 to the Island of Newfoundland, after delays due in part to questions of treaty rights. In Australia it was conferred on New Zealand in 1852, on New South Wales and Victoria in 1855, and on Tasmania and South Australia in 1856, while the newly-created colony of Queensland was on its creation in 1859 granted at once responsible government. Western Australia, through lack of population, only received responsible government in 1890, and then with certain reservations. In South Africa the Cape of Good Hope long hesitated as to whether it should accept the boon which the Home Government offered it, but did so finally in 1872, while, after some hesitation partly on the side of the colony and partly of the Colonial Office in view of the difficult problem of defence, Natal obtained self-government by a Local Act of 1893. Since that date the Letters Patent of 1906 have conferred responsible government on the Transvaal, and those of 1907 on the Orange River Colony, in either case without any intermediate period of representative government.

Imperial Interests.

While these successive grants have deprived His Majesty's Government of any direct control over all those colonies which have a large resident white population, the indirect control has steadily been diminished, and where it is retained the mode of its exercise has been substantially altered. Lord Durham gives a list of the subjects in which he considered interference proper, as the relations between the colony and the Mother Country were affected thereby. The list includes only "the constitution of the form of government, the regulation of foreign relations, and of trade with the Mother Country, the other British colonies, and foreign nations, and the disposal of the public lands;" in all other matters the colonists should have a free hand, as they were the most interested in their own administration and legislation, and were those on whom the results of unsatisfactory government first recoiled. He laid special stress on the necessity of leaving to the local government all patronage, a recommendation not altogether palatable at a time when posts in the colonies were a recognised means of provision for younger sons.

Lord Durham's list is scarcely a complete one either in theory or in fact; but what he omitted was no doubt due partly to local circumstances and partly because it seemed to him obvious. The native problem did not then present itself in any marked form in Canada, where the Indians were too few and scattered to invite the interference of the Imperial Government on their behalf, and where, indeed, the great majority of the Indians were situated in provinces which in 1838 were not ripe for self-government; and it probably seemed evident to any Imperial officer in 1838 that in military and naval matters the Imperial Government remained supreme.

Characteristics of Responsible Government.

The essence of the new system lay in the substitution as advisers of the Governor of ministers representing the majority of the Colonial Legislature for officials nominated by Downing-street. It was, of course, inevitable that some years should elapse before the new arrangements were fully understood either by Governors or by ministers and, on both sides, claims were advanced which could not bear scrutiny, and which may now be regarded as only of historical interest. But from the earliest days of the working of the system, it was realised that there were real and substantial questions for solution, those arising out of the peculiar position of the Colonial Governor—as at once the head of the Government and an Imperial officer responsible to the Crown through Imperial ministers—and, in particular, through the Secretary of State for the Colonies.

Position of Colonial Governor.

This double capacity at once differentiates the position of a Colonial Governor from that

of the Sovereign in the United Kingdom. It is true that in law and fact a Governor, even a Governor-General, is not a Viceroy, and that the degree to which he represents the Sovereign depends on the terms of the Letters Patent creating his post, or of local legislation. But, at the same time he is, in some respects, less under ministerial control, than a constitutional monarch. Such a monarch, in the event of a dispute with a ministry commanding popular support, must yield, or the throne would be endangered; in the case of a Governor, the worst that can happen is recall, and some loss of prestige in the office of Governor, and this fact leaves open to the Governor, even at the present day, a certain sphere within which he can act on his own discretion.

It has indeed been held by distinguished authorities that in all matters, or, at any rate, in all matters not of Imperial concern, a Colonial Governor must act on ministerial advice. "A Governor is now politically a cipher," writes Mr. Goldwin Smith, "he holds a petty Court and bids champagne flow under his roof, receives civic addresses, and makes flattering replies; but he has lost all power, not only of initiation, but of salutary control." Both legally and constitutionally this view must be regarded as unduly emphasising the dependent position of the Governor. It is a mistake to suppose that legally the Governor of a self-governing colony is bound to act on the advice of his ministers. It is true that in many colonial laws it is the Governor-in-Council who is authorised to do certain acts, and in some constitutions it is specifically enacted, as in the constitutions of the Dominion of Canada and the Commonwealth of Australia, that the expression Governor-in-Council signifies the Governor acting with the consent of his executive council. But even in these cases the Governor is under no obligation to act; he cannot do the act without the concurrence of his council, but he can refuse to act, and can endeavour to obtain other ministers to carry on the Government. In very many cases, however—and in this matter there seems to be no fixed practice even in the same Dominion—the powers granted are granted to the Governor simply, and in these cases legally he is free to act as he pleases. No doubt his discretion is fettered in point of fact by the Royal Instructions which command him to take the advice of ministers, but the Instructions have not the effect of a Statute, and in them he is expressly permitted, if he considers it essential, to overrule his ministers. It is true that in the case of Canada and the Commonwealth of Australia no such permission is included in the Royal Instructions, but it was expressly recognised by the Canadian Minister of Justice, Mr. Blake, at whose suggestion the alteration in the Canadian Instructions was made in 1877, that the alteration, while distinctly indicating that as a rule the Governor does and must act through the agency and by the advice of ministers, did not deprive the Governor-General of his right to do otherwise in those rare cases in which owing to the substantial Imperial interests involved it was considered that full freedom of action was not vested in the Canadian people.

The Governor as a Colonial Officer.

It will be noted that, like Mr. Goldwin Smith, Mr. Blake considered that a Canadian Governor-General could constitutionally hardly ever act against ministerial advice save on Imperial grounds. This view is not unnatural in the case of Canada, as a Federal Government must ever command the greatest consideration at the hands of a Governor-General, while of recent years the great preponderance of one party has rendered it obviously impossible for any Governor-General to hope to obtain other advisers who could command a majority in Parliament. But in Australia there is abundant warrant in the most recent constitutional practice for the refusal of the Governor to accept ministerial advice if he thinks he can obtain advisers whose views are more in sympathy with those of the people. The right has recently been exercised by the Governors of Western Australia and of Queensland, in both cases in matters arising out of disputes between the two Houses of the State Parliaments. The circumstances of the Queensland case are too familar to require recapitulation, but the Western Australia precedent is no less important though less well known. Mr. Moore's Government in Western Australia brought in and passed easily through the Lower House a Bill for a land tax, which the Legislative Council declined to accept. Ministers then desired the Governor to grant them a dissolution, which Sir Frederick Bedford declined to do, and equally he declined to accept their resignations, and instead arranged for a prorogation of Parliament with the aim of arriving at a compromise between the Houses, a plan in which his ministers acquiesced and which appears to have won general approval in Australia.

In such cases the Governor's action can, it

is clear, only be justified by the belief that he is thus enabling the people to express their will. However much personally he may dislike the policy adopted by his ministers, he must not compel them to resign unless he is satisfied that there is reason to think that they do not speak with the authority of the people. He has no right to inflict on the country the waste of time, the expense, and the annoyance of a general election to satisfy his own conscience, which he can more properly relieve by resignation. But the difference between his position and that of a constitutional monarch does enable him to try a change of ministers in circumstances in which such a monarch could not act. It is not now really within the bounds of practical politics, that such a monarch should, *proprio motu*, dismiss his ministers, or force them into resignation, so long as they commanded a majority in the Legislature. But if a Colonial Governor has miscalculated, he simply accepts the advice of his former ministers when they return with a Parliamentary majority. In no circumstances would he be justified in disregarding the decision of the people in a matter of this kind; if he did, his recall would be inevitable. The limits within which a Governor should act may be illustrated by the conduct of Sir G. le Hunte, Governor of South Australia, in 1906, again in a case of a dispute between the two Houses of the Legislature. The Lower House was anxious to diminish the property qualification of the electors of the Legislative Council, and the Council were unable to see their way to accept the proposals of the Premier. He, therefore, approached the Governor with a request for a dissolution as a preliminary to steps to overcome the resistance of the Council. The Governor was reluctant to dissolve a House which had just been returned at a general election, and so waste the Parliamentary session, when many important measures awaited disposal, and declined his request. Ministers then resigned, and Sir G. le Hunte sent for the leader of the Opposition, and asked him to form a Ministry. He could not, however, do so, and the Governor, instead of granting him a dissolution on the chance that he might find it possible to obtain a majority, recalled his ministers, and granted their request for a dissolution, despite the loss of the Parliamentary session.

It will be seen that in all the cases cited disputes between the Houses of the Colonial Parliament were the occasion of the Governor's exercise of his personal discretion. The explanation of this fact is of course that such disputes only arise when parties in the country are of approximately equal strength, and that it is in these circumstances alone that the Governor can safely act on his discretion. In local matters it would nowadays be preposterous for a Governor to reject ministerial advice if the Ministry had the confidence of both Houses of Parliament save under very exceptional circumstances. He would be justified, indeed, in refusing to act illegally, at any rate when the illegality was clear, and if a Colonial Government should actually endeavour to use him in the perpetration of a gross wrong—an inconceivable case—he could, no doubt, justify refusal to accept their advice, even although it might render it essential for him to resign. But it is not likely that modern cases of such action will arise, and on the whole the field on which a Governor is free to use his personal discretion may fairly be said at the present time to be confined to cases when he has reason to believe that the majority in the Lower House of the Legislature—which of course determines the Government of the day —does not really represent the views of the people.

The Governor as an Imperial Officer.

But there is another and for us more important aspect of the Governor's position. He is an Imperial officer subject to His Majesty's instructions whether conveyed formally by Royal Instructions under the sign manual and signet, or informally by a Secretary of State. Such instructions are not laws and breach of them neither invalidates the Governor's acts nor renders him liable to suit, but the Crown would, of course, be justified in immediately recalling the offending officer. Naturally as the Governor has no staff of Imperial servants these instructions cannot and do not direct him to do specific executive acts, and are confined to giving him directions as to the use for his power to reserve colonial legislation or the consideration of the Home Government and the prerogative of pardoning criminals. The legal right of the Imperial Cabinet—or technically of His Majesty—to give such instructions is beyond doubt. Save in the case of the Commonwealth of Australia, the constitutions of the self-governing Dominions expressly authorise the Crown to issue instructions as to the reservation of Bills, though an Imperial Act—the Colonial Laws Validity Act, 1865—provides that neglect of these instructions does not invalidate a law if assented to. The pre-

rogative of pardon is one of the most undoubted prerogatives of the Crown, which is clearly entitled to subject its delegation to whatever restrictions it deems desirable.

Disagreement between Colonial and Imperial Governments.

There arises, however, a serious difficulty when the Governor endeavours, in opposition to the wishes of ministers, to carry into force a policy approved by the Imperial Government. It is, of course, clear that if he can find other ministers ready to accept responsibility for the policy and able to carry on the government, then he is relieved from all difficulty. But it is obvious that the colony, as a whole, might support the Government, and that an alternative ministry might be impossible. In that case, is it constitutional for the Government to resign, leaving the Governor without a ministry, and without the means of carrying on the ordinary government of the country, in the hope that by so doing they may force the hand of the Secretary of State? The answer must surely be in the negative; since the Colonial Government can hardly put itself in the position of passive resistance, and the constitutional method of asserting its rights is discussion and protest. This view is supported by the usual practice, including a precedent of great importance. In the dispute between Lord Glasgow and his ministers, in 1892, as to the addition of members to the Legislative Council of New Zealand, ministers despite the refusal of the Governor to accept their policy, remained in office, and justified themselves by the view that "if it be the right and duty of the Governor to act in any case contrary to the advice of his ministers, they cannot be held responsible for his action, and should not feel justified in retiring from the administration." In this case the Governor acted on what had formerly been the view of the Colonial Office as to the Governor's attitude in these cases, and not on any express instructions; but the reasoning of ministers would apply even more forcibly to such a case. On the other hand, it is obvious that the Imperial Government is bound to do all in its power to avoid placing ministers in the position of accepting a policy with which they are not in hearty sympathy.

Relaxation of Imperial Control as to Public Lands.

As a matter of fact the Imperial Government has surrendered one by one its powers of control over colonial administration and legislation. At first, in Canada, it was felt to be indiscreet to hand over all the Crown lands to the disposal of the mere handful of settlers instead of keeping them in the hands of the Imperial Government as trustee for the Empire, but in 1847 a full surrender was made, while the establishment of the principle of self-government in Australia was accompanied by the repeal of the Acts relating to waste lands in the colonies concerned. In 1890 the tiny population of Western Australia were entrusted with the sole control of nearly 600 million acres of land, much of which was and still is unexplored. Similarly the Cape, Natal, Newfoundland, and New Zealand have been permitted to work out their own policy as to their public lands. It may be argued that in this matter His Majesty's Government have shirked Imperial obligations to avoid unpopularity, but no one who studies the records of the representations made on this subject to the Imperial Government will doubt the wisdom of the concession.

Trade Relations.

In the case of trade relations similar concessions have been made. Neither Lord Durham nor any of his contemporaries would probably have looked forward to the possibility of Canada at an early date exercising full powers as regards Customs matters. But as a matter of fact the last tariff framed for North America by the Imperial Parliament was that of 1842. A complete change in the situation of affairs was created immediately afterwards by the adoption of the policy of Free Trade in Great Britain, and an Act of 1846 gave Canada power to repeal duties imposed on foreign goods under Imperial Acts. The policy of the Imperial Government still prohibited differential duties as against one British colony in favour of another, and it was not until 1861 that the principle of mutual preferences among the Canadian colonies was accepted, an arrangement superseded later by federation. In Australia the prohibition against differential tariffs was enforced by an Imperial Act of 1866, and it was not until 1873 that inter-colonial preference was allowed, and even then it was expressly laid down that differential duties should not be levied on British or foreign goods. The last remnant of the system did not disappear until as late a date as 1895 when an Imperial Act expressly swept away all these restrictions on the freedom of action of the Australian colonies.

Despite the disappearance of these formal restrictions, however, the Imperial Government, with the approval of the Colonial Governments as shown at the Colonial Conferences of 1894 and 1902, and by the recent action of Canada in extending to all British Colonies and Protectorates the benefits of the French treaty, has established the rule that no colony shall give any trade preference to a foreign power which is not also extended to every British colony and to the Mother Country. An interesting example shows, however, the unwillingness of His Majesty's Government to interfere save in cases of great necessity with colonial action. In 1890 a commercial convention was arranged between Newfoundland and the United States, but the Government of Canada remonstrated on the ground that a serious blow would thus be struck at its trade, as the United States would be able to obtain from Newfoundland the very articles on which the Dominion Government were anxious to obtain a preference for Canada, and on this ground only the Imperial Government declined to ratify the convention. In 1903, however, Sir Robert Bond succeeded, with the assistance of the British Ambassador at Washington, in arranging a new convention, and His Majesty's Government no longer refused to ratify the convention, although, as a matter of fact, the United States Senate has hitherto declined to accept it on the ground that it is contrary to the interests of the New England fishermen. Moreover, the Government took active steps, when the Transvaal and the Orange River colonies were still under their control, to secure the formation of the South African Customs Union, which applies to South Africa the principles of inter-colonial preference.

Shipping Legislation.

The history of shipping legislation tells the same tale. It was partly in deference to the strongly expressed wishes of Canada that the repeal of the Navigation Acts took place in 1849, and as early as 1857 the Customs Consolidation Act established the right of Colonial Governments to regulate all the details of their Customs administration by suspending the operation of the British code whenever a colony had made complete provision for the management of its Customs affairs. In 1869 the further step was taken, by an Act, which was not even discussed in Parliament, to hand over the whole control of coasting trade, which had been reserved in 1849, to the Colonial Legislatures, subject only to the proviso, which still appears in the Consolidating Act of 1894, that vessels registered in the United Kingdom, or any other British possession, shall not be treated worse than ships registered in the possession itself. Moreover, any colony may regulate, by its enactments, any vessels registered in it, and these enactments are valid even beyond the limits of the colony. Indeed, as the Colonial Merchant Shipping Conference last year showed, the only vessel not subject, while in colonial waters, to colonial legislation is the vessel which strictly confines itself to oceanic trade, and, if it calls at more than one port in any possession, merely puts down or takes up oversea passengers or cargo, a fact which, in view of the enormous British interests involved in the shipping trade, is conclusive proof of the unwillingness of the home government to impose any unavoidable restrictions on colonial Legislatures.

Military and Naval Affairs.

In military and naval affairs the same progress is manifest. In the early years, after the grant of responsible government, the somewhat absurd claim was advanced that the Imperial troops still retained in the colonies were to be considered to be under the control of the Colonial Governments, and in 1857 this claim was actually put forward by the Government of New Zealand, which protested against the action taken by the Governor, with the approval of the Secretary of State, in regard to the custody of certain prisoners of war. It was pointed out in reply that the operations had been carried out by the forces of the Imperial Government, and that Government, having borne the burden of the operations, must have the deciding voice in the disposal of the prisoners. Such disputes became impossible in the Australian colonies, with the gradual withdrawal of the Imperial garrisons, after 1867, and similarly in Canada, while the Red River rebellion was suppressed by the advance of a mixed body of Imperial and local forces, the North-West rebellion of 1885 was put down after some hard fighting by local troops only, though it was not until quite recently that the Canadian Government undertook the duty of supplying garrisons for Halifax and Esquimalt.

In South Africa the position has been and still is obscured by the existence of Imperial dependencies alongside of the self-governing colonies. It was on this ground that Sir

Michael Hicks-Beach based his approval of the action of Sir Bartle Frere, in 1878, in dismissing the Molteno Government. Mr. Molteno made no claim to control the Imperial garrison, but he contended that it was for the Cape ministry to determine whether or not the services of the Imperial troops were required. As the Secretary of State pointed out, the Governor of the Cape was also the High Commissioner for South Africa, and in that capacity could not be bound by the advice of the Cape Government, and must take such measures as might be expedient for the safety of British South Africa. Fortunately, the home Government's view of the situation was accepted by the Cape constituencies, which gave Mr. Sprigg a substantial majority, or there would have arisen a position of the serious character indicated above, a position which threatened to arise during the late hostilities in South Africa. It is, of course, obvious that in the case of war, as in the South African war, the decision in local affairs must rest with the Imperial Government, which supplies the troops and the money to defray the cost of the operations, and that even in minor operations if Imperial assistance is required the Imperial Government acquires a right to be consulted in the subsequent settlement.

In all other matters, however, no attempt at Imperial control is maintained, and the arrangements for military command in Australia, New Zealand, and Canada have of late been considerably modified without protest from home. Similarly Lord Tweedmouth at the Colonial Conference of 1907 accepted the principle of the establishment of a separate Australian navy not directly under Imperial officers.

Constitutional Development.

Nor has any attempt been made to impede constitutional development. It was indeed originally deemed essential to make colonial constitutions practically rigid, and to allow alteration only under circumstances which ensured the assent of His Majesty's Government before any alteration could come into force. This was the case with the constitution of Canada in 1840, and for this reason the Constitution Acts of all the Australian States with the possible exception of Tasmania contained a formidable list of classes of Acts amending the constitution which could only come into force after approval by His Majesty in Council and in certain cases after being laid before Parliament. The result was infinite confusion which led to the passing from time to time of Imperial Acts to validate Colonial Acts whose validity was on one ground or another questioned, and last year, for the first time, saw the reduction of the system to reasonable simplicity by the passing of the Australian States Constitution Act, which requires reservation of only such Acts as are of first-rate importance and abolishes the obsolete practice of laying Bills before the Imperial Parliament. In the modern constitution of the Commonwealth of Australia, alteration of the constitution by the Legislature and a referendum is elaborately provided for, while the constitutions of the Orange River Colony and the Transvaal permit alteration by ordinary legislation which must be reserved for the royal assent. In Canada the right of altering the constitution, save in certain details, remains in the Imperial Parliament only, but that is in accordance with the wishes of the people of Canada, who still desire, as in 1867, that the British North America Act should be regarded as a formal compact of union endowed with all the authority belonging to a document which no power in Canada can modify. In New Zealand, in which, under the Constitution Act the powers of the Dominion Legislature are somewhat restricted, no disposition to demand greater freedom seems to exist. Sir Joseph Ward lately, in opposing the proposal of the election of the Legislative Council, which at present is nominated, mentioned that the abolition of the Council would require an Imperial Act, but he did not suggest that he regarded such an Act as desirable.

External Affairs.

It is naturally with regard to external affairs that the interference of the Imperial Government is at once inevitable and justifiable. It is clear that if the Empire is to enjoy her rightful share of power and influence among foreign nations she must act as a whole. Whatever the growth of population in Australia may be she could never as a distant power command the same weight as an Empire which included Canada and South Africa besides the British Islands and India. In conducting negotiations with foreign powers the Imperial Government cannot merely devote itself to the interests of any one part of the Empire, and inevitably on some occasions there must be disputes, in which the Imperial Government must have in the long run the last word. But it is the policy of the Imperial Government steadily to diminish the cases in which such disputes can arise by

associating Colonial Governments with her in arranging treaty stipulations. For this reason were denounced the treaties with Germany and Belgium in order to enable Canada to give preferential treatment to the Mother Country and other British colonies, and the fixed rule has been adopted since 1900 of securing for all British colonies, including even the Crown colonies, the right to adhere separately to or to withdraw from treaties concluded by the Imperial Government.

This principle, as regards commercial treaties, was expressly recognised in 1877, when new treaties with France and Italy were under negotiation, and, in 1881, Canada was assured that her wishes would be ascertained and followed in making treaties affecting her. Further, there has grown up the established practice of associating a colonial representative in the negotiation of treaties directly affecting that colony, as in the case of Sir John Macdonald's share in the treaty of Washington, and Mr. Fielding and Mr. Brodeur's participation in the recent negotiations for a treaty with France.

Asiatic Immigration.

Serious questions have arisen with regard to immigration, especially from Asiatic countries. In 1877, the Governor reserved, despite the protests of his ministers, a Queensland Bill for the exclusion of Chinese, and the Colonial Secretary ultimately declined to sanction the Bill. However, subsequent legislation in all the Australian colonies was allowed, and the same policy of restriction was adopted by Canada in 1885, and has been enforced by a later Act of 1903, in the Cape by an Act of 1904, and more recently by Newfoundland. In the case of China, however, the treaty of Pekin is unilateral, and while requiring the free entry of British into certain parts of China gives no reciprocal right of Chinese entry upon British territory, such as is contained in the treaty with Japan, which has been accepted by Canada on behalf of the Dominion, and the exclusion of Chinese was not contrary to treaty rights. A more difficult question arose out of the determination of the colony of Natal and of the Australian colonies, to put restrictions on the immigration of Her Majesty's British Indian subjects. On this point eventually Mr. Chamberlain deemed it advisable in 1897 to accept a compromise, on the basis that mere colour should not be made a ground for exclusion, but that an education test should be adopted instead. This solution was accepted by Natal, and has since been steadily acted upon, appearing in the Australian Commonwealth Acts of 1901 and 1905, which allow the entry of the Indian student and substantial merchant, while securing the exclusion of the special bugbear of the Australian public, the so called "Afghan" pedlar.

The interpretation of treaties rests, of course, with the Imperial Government, and in 1891 a Bill was actually brought into the Imperial Parliament to give power to enforce the interpretation put by His Majesty's Government on the treaty rights of France in Newfoundland, and was only withdrawn on the Colonial Government undertaking to pass the necessary legislation. But it is now a fixed rule to obtain, if possible, the concurrence of Colonial Governments in any foreign questions affecting them, and to meet their wishes if practicable. On this ground His Majesty's Government were prepared to annex the territory known as German South-West Africa on the Cape accepting responsibility for it, and actually did annex part of British New Guinea at the wish of the Australian colonies. Similarly a loan was guaranteed by Great Britain for Canada to aid her in acquiring the Hudson Bay Company's territories, and the consent of Canada was obtained and her co-operation secured in the negotiations of the Joint High Commission in 1898, and in the reference to arbitration, in 1903, of the Alaska Boundary dispute, while the concurrence of Australia and New Zealand was recently sought for in the arrangements with France for the establishment of a joint protectorate in the New Hebrides.

Native Rights.

Much more doubt has been thrown on the claim of the Imperial Government to concern itself with native rights. The earlier constitutions contained few provisions on this head except in so far as treaty rights were concerned, mainly because the absence of natives in any considerable numbers in the colonies affected made the matter one of no moment. In New Zealand and South Africa the case was otherwise, but when responsible government was given to the Cape no special provision was felt to be necessary owing to the existence under the constitution of no colour distinction in voting rights, the strong position thus secured to the native vote preventing any chance of ill-treatment on a serious scale. But

in Natal, where this rule did not exist and where very few natives had or could obtain the franchise, it was felt desirable at once to reserve a sum to be applied for their benefit, and to vest the control over the native tribes in the Governor by instructing him to act, after hearing his ministers' advice, on his own responsibility. No provision to enforce this rule was, however, made and practically the Governor has acted on the advice of ministers whose task has been a difficult one, especially since the handing over of Zululand in 1897 from the administration of the Imperial Government added to the problem the duty of controlling those warlike tribes.

In Western Australia more effective provision was made for the welfare of the aborigines by establishing a department independent of ministerial control, charged with the superintendence of their welfare and the expenditure of the sums reserved for their benefit. This arrangement, however, was strongly resented, and the department was, with Mr. Chamberlain's consent, subjected in 1897 to ministerial control. The Transvaal Letters Patent do not include any reservation of money but invest the Governor with the vague powers of Supreme Chief, and secure that any native lands shall not be alienated save under the authority of a law. Both in South Africa and Australia difficulty has arisen from the treatment of British Indians, and the Transvaal and Orange River Colony Letters Patent require reservation of all Bills imposing disabilities on non-Europeans.

There are, therefore, good grounds for maintaining the right of disallowance of colonial legislation and of requiring the reservation of Bills in certain cases by colonial Governors. It was proposed in the constitutions drafted in 1854 by the Legislatures of New South Wales and Victoria to establish a distinction between acts of Imperial and of local interest, and to require the Governor on his own responsibility to assent to or to reject them, while permitting him to reserve and Her Majesty to disallow acts affecting Imperial interests, which were defined as Acts dealing with questions of allegiance, naturalisation, treaties, political intercourse with foreign Governments, the discipline of the troops and defence, and the law of high treason, and, in the case of Victoria, of divorce. This proposal was definitely rejected by the Government of the day, and experience shows conclusively that their decision was wise. The Governor would have been forced to accept every Act of local interest unless he could obtain new ministers and the home Government would have had to resort to the undesirable step of specifically legislating to override colonial laws. It is not, of course, desirable that the legislation of a Dominion should, on Imperial grounds readily be disallowed, and the recent Parliamentary returns show how seldom it is now found necessary to use this power, but the fact of its existence gives the Imperial Government a position to ask for minor amendments, as is often done, while the utility of the power of reservation has recently received striking illustration from the case of the British Preference Bill of the Commonwealth Parliament, which conferred on British trade privileges incompatible with treaty obligations, and which was, therefore, properly reserved with the consent of the Commonwealth Government for the signification of His Majesty's pleasure. It is clearly much more convenient that a Bill which is likely to be disallowed by His Majesty's Government should be reserved, and so never come into force than that after a few months' existence as law it should be disallowed. What is essential is not that Colonial Acts should be exempt from disallowance or reservation, but that such Acts should only be disallowed on Imperial grounds, and, pending a practical scheme of Imperial Federation, the decision as to what are adequate Imperial grounds must rest with the Imperial Government after full consultation with the Government of the colony concerned, and of any other colony which may be interested.

No doubt at one time the disallowance of Acts rested on no very sound basis of Imperial interest, *e.g.*, Deceased Wives' Sisters Marriage Bills were repeatedly not sanctioned —but in 1899, after some hesitation, the rule was finally laid down that in mere matters of local interest, however, important, the Imperial Government would not interfere. This was done in respect of the proposal in Newfoundland to dispose of the railway, a proposal which raised widespread discontent in the colony, and which presented many grave defects. Mr. Chamberlain, while pointing out in detail the objections which could legitimately be offered to the proposal, definitely declined to interfere with the legislation of the colony, when Imperial interests were not affected, merely reserving as a possible subject for interference a case in which the Colonial Government might be charged with bad faith, and certainly since that date no Act of local interest has been disallowed or reserved.

PREROGATIVE OF PARDON.

The same doctrine of Imperial interests has been made the touchstone for the exercise of the prerogative of pardon which is always delegated to the Governor by the King. In the early years of responsible government the exercise of the prerogative was carried on in a somewhat haphazard way in several colonies; in one case indeed it was the custom for the Governor to leave signed pardons in blank for use in his absence. Lord Kimberley, in 1871, laid down that the Governor must, in each case, decide after taking the advice of ministers, but on his personal responsibility, and, after a heated correspondence between Sir Hercules Robinson and Mr. Parkes, in 1874, Lord Carnarvon definitely decided that the Governor was entitled to receive the advice of ministers, but must take personally the responsibility for decision, thus relieving ministers of the political and social pressure which would otherwise be brought to bear upon them. This doctrine was embodied in the permanent Letters Patent issued, in the decade 1870-1880, for all the Australian colonies and New Zealand, and, in virtue of it, Lord Dufferin, in Canada, decided on his personal responsibility to grant a pardon to Lepine, in 1875, and referred the case of Peter Martin home for instructions, in 1877. But in revising the Canadian Letters Patent, in 1877, at the suggestion of Mr. Blake. the Governor-General was only required to assume personal responsibity when the interests of the Empire, or of any country other than the Dominion, were at stake. The same form of words was introduced into the Australian Instructions in 1895, and was adopted for the Instructions to the Governor-General of the Commonwealth in 1900. The older form is, on the other hand, retained in cases like the Cape, Natal, and the Transvaal and Orange River Colony, where the existence of a large black population renders the exercise of the prerogative a matter of singular importance. But even in these cases the new form would be adequate, inasmuch as the expression, "interests of the Empire," includes all the complicated questions of native races in South Africa. In point of fact the exercise of the prerogative of pardon is now assimilated to any other executive action of the Governor; if he disregards ministerial advice, it must be on grounds of Imperial interest which he can substantiate to the satisfaction of the Secretary of State, though naturally the peculiar nature of the prerogative would render it, if used contrary to the advice of ministers, less of a cause of offence than would be the case with any other executive act. One other small concession has recently been made to colonial wishes in the case of the Cape and the Transvaal. In earlier times it was quite usual to banish offenders for other than political crimes, but after the case of the bushranger Gardiner, in 1874, the Secretary of State pointed out the grave objections to this mode of procedure, and thenceforth banishment was confined to political offences unaccompanied by other grave crime. After the passing of the Aliens Bill of 1904, it was felt no longer possible to maintain this position, and at the request of the Government of the Cape, the Cape Letters Patent were amended to permit the banishment of any person not a British subject, or domiciled in South Africa, and the same provision appears in the Transvaal and Orange River Colony Letters Patent

RESTRICTED USE OF IMPERIAL POWERS OF LEGISLATION.

In this connection attention may also be called to the practice of assigning increasing importance to colonial opinion in the use of the peculiar powers of the Imperial Parliament, by which it can legislate for the whole Empire and for things taking place beyond the territorial waters of the colonies. In the case of the Extradition Acts their operation is suspended in Canada so long as the Canadian Extradition Acts are in force. Efforts are still being made to secure an Imperial naturalisation code, and English legislation on the subject has been delayed, pending some agreement with the colonies. Care was taken to exclude the colonies from the operation of the new Merchant Shipping Act of 1906, though they were invited to adopt its principles if they thought fit. The case of that Act is, indeed, almost an extreme example of the unwillingness of Parliament to pass legislation affecting the colonies, for its terms were not made applicable even to Crown colonies, while the Act of 1894 legislated freely for all the British dominions. Similarly, in 1905, when the Act to enable the Royal Commission as to stores, to compel the attendance of witnesses, &c., was being passed, its operation was restricted to the United Kingdom, although it was essential for the Commissioners to take evidence in South Africa, and though grave Imperial grounds could well have been urged in favour of extending the effect of the legislation to the colonies concerned.

Judicial Appeals.

Even in regard to the question of appeals to the Privy Council, concession has been made to Canada and to the Commonwealth of Australia. When the Supreme Court of Canada was established by a Dominion Act in 1875, it was intended to forbid any appeal to the Judicial Committee of the Privy Council, and to make the Supreme Court the final appeal court for Canada. It was then intimated by the Imperial Government that if the Bill were passed in that form, they would be unable to advise Her Majesty to assent to it, and in consequence the measure became law in such a form as to leave untouched the right of Her Majesty to grant special leave to appeal from a judgment of the Supreme Court of the Dominion, while appeals from the High Courts of the provinces still lie direct to either the Privy Council or the Supreme Court, at the option of the litigant. But in 1887, Her Majesty was advised to assent to an Act of the Dominion Parliament making the Supreme Court's decision final in all criminal cases. In the case of the Commonwealth, His Majesty's Government, after long discussions in the Imperial Parliament, in 1900, agreed to leave the High Court of Australia as the final arbiter in all cases affecting the rights of the Commonwealth as against the States, or of two or more States *inter se*, though it remains open to the High Court to give a certificate permitting further resort to the Privy Council. These two cases in Canada and the Commonwealth afford the only exceptions to the general rule that any of His Majesty's subjects can obtain redress for miscarriages of justice in colonial courts on appeal to His Majesty in Council.

DISCUSSION.

The Chairman (Sir Charles Dilke), in opening the discussion, said the author began his most interesting and admirable paper by alluding to the new name which had been given to the Colonial Conference, namely, the Imperial Conference; and it was difficult to speak at the Society of Arts that day without alluding to the new name which had been granted to the Society, namely, that of the Royal Society of Arts. The Imperial term was one which suggested a curious historical reference. The Crown was declared an Imperial crown in old days in connection with the pretension of the holy Roman Empire to be a crown superior to other crowns, and also in connection with certain Papal pretensions. In the reign of Queen Elizabeth, the crown became for a moment definitely Imperial in the present sense, by the title at one time assumed by Queen Elizabeth, of Empress, including the Crown of England, Ireland, France, and Virginia. In that title, the position of Virginia as one of the dominions of the Crown, under a separate kingdom held by the King of England, was expressly recognised, and the whole of Sir Walter Raleigh's imperial system was based upon that principle. The author had described the historical interest of the regression or retrogression which had occurred in many cases in the Colonial Governments, a very remarkable example of which was afforded by some of the original American colonies. The colony of Virginia never developed in its early stages to a high point of government, but in Carolina it was otherwise. In Carolina the powers of self-government conferred in the earliest Charter were extreme. Even in the latest seventeenth century Charter, the inhabitants were to "choose from among themselves 13 persons . . . . one whereof the proprietors will appoint for Governor and half of the others for his council, which the Governor is to rule for three years, and then learn to obey." Those words would be found printed in Professor Hugh Egerton's admirable book, the "Short History of British Colonial Policy." The same extended powers of self-government were to be found in the early government under the Crown of the Commonwealth of Massachusetts, where the same words were used as in the Carolina Charter, including "They shall choose for themselves an assembly." The Charter of the Commonwealth of Massachusetts was modified after the fall of the Protectorate, and the Restoration; but even in the latter form, in 1691, it was very free, and gave to Massachusetts an annually elective assembly, with the complete power of taxation and of legislation which was not repugnant to the law of England. As the author said, Colonial Government went through a long period of retrogression, and this had also been proceeding quite recently in the West Indies. In the case of Jamaica, there was not only the withdrawal of the constitution, to which the author had alluded in the paper, but the subsequent withdrawal even of what was left. One great difficulty which had arisen in all those cases was pointed to in many parts of the paper. For instance, in the early part of his paper the author stated that, in the case of certain colonies which he named, the Imperial Government was trustee for the interests of the comparatively large native population, and that was the ground which he gave why those particular colonies were likely to remain in a state of imperfect development. A little further on the author returned to the question, where he described, under the heading of "Imperial Interests," the difficulty of giving direct control to the Imperial Government in cases where there was a large resident white population. The author would be the first to feel that that test was a little vague, because the mere largeness of the population did not take into consideration its relative largeness. For instance, while we had never

been asked for completely responsible institutions in Ceylon, there was a very natural demand for a larger amount of elective representative institutions there, there being a large white resident population in one sense of the word. On the other hand, rightly or wrongly, this country granted self-government in the fullest form to Natal, where the white population of all kinds was still under 100,000, compared with 1,100,000 blacks of one kind and another. So that the question of proportion, as well as of absolute number, could not fail to be considered in those cases. Everyone was familiar with the obvious difficulties which arose almost every day in connection with the matter, and the same question was referred to over and over again in the paper. For instance, an important allusion was made to it, where the author spoke of the retention of Imperial control over the lands of the Colonies, stating that the Cape, Natal, Newfoundland, and New Zealand had been permitted to work out their own policy as to their public lands. But there arose the question of what exactly was the colony to which the high powers of self-government were granted, because in Natal and the Cape, communities had been handed over to the Government, at one time or another, which were not actually a portion of the colony. In connection with Natal, that happened at first with Zululand, and it was so much the case with Basutoland in connection with the Cape, that the Cape, after the Basuto war, appealed to us to take Basutoland back again, and this country did take it back, and held it now by the desire of the Cape. The difficulties were not solved in that way, in fact in some sense they were insuperable, *i.e.*, they were perpetual, and were likely to be in an Empire like the British. Towards the end of his paper, under the heading of "Native Rights," the author mentioned the reservation of the nominal powers of the King as paramount chief in some cases, stating that no provision was made to enforce the rule, and that practically the governor acted on the advice of ministers. That had been the case. It was a very grave question how far the promises that were made as to the use of the powers of the paramount chief were substantially observed towards the native tribes, when the governor was compelled in practice to act upon the opinion of the Minister of Native Affairs to whom those powers were delegated, and who was, of course, one of the ministers of the day of the colony, who might represent only the opinion of a comparatively small white population in the colony in a matter in regard to which the Imperial Government had really made promises to the natives concerned, in some cases promises made in the solemn form of treaty rights. The Transvaal Letters Patent were mentioned as investing the governor with the vague powers of supreme chief, the terms used being the same as those which were made use of in the case of Natal. That was not a very great security, because in Natal those powers had been exercised on the advice of the minister of the Crown. The last reference to that grave and important subject was a little further on, where the author said that the term "interests of the Empire" was sufficient because it included all the complicated questions of native races. In practice it was not always permitted to include them, and the difficulties were not solved by any of the admirable principles which, up to the present time, they had been able to agree in laying down. He would say no more on that dangerous and complicated subject, but go back to an earlier part of the paper where reference was made to the cases where the powers of a colonial governor were different from the powers of the Constitutional king. It was a very open question as to what were the powers of a Constitutional king in reference to that subject. When, in the change of Government in France under Marshal MacMahon, a Ministry, which thought it had the countenance of the country, and ultimately proved that it had, was dismissed from power, and a new Ministry was called to power, an English precedent was discussed in France; and he thought they succeeded in showing that, if they had had a majority—which they had not—they would have a good deal to say for the doctrine upon which they proceeded. He was not sure that constitutional students would admit there was a difference, and that the King of England would not be justified in dismissing a Ministry where he was convinced that that Ministry did not possess the confidence of the country. He thought that was an open question. They fell back upon the convenient "Pinafore" form of "hardly ever." The words "hardly ever" were familiar to all as being connected with the question which followed, "What, never?"; and the author rightly, he thought, concluded that, whether the position of a Colonial Governor be or be not theoretically different in any degree from that of a Constitutional king, nevertheless, he would hardly ever be justified in acting against the advice of his Ministry. In that they would all agree. In the case of Victoria, there was a deadlock which forced the then Governor to appear to take sides, whether he did so or not. He was accused on both sides of the world of having taken sides, and the famous deadlock occurred, which was at one time accompanied by the somewhat curious action of stopping the salaries of all the civil servants in the colony, and of allowing those who were friendly with the Ministry and the popular party to bring actions for the recovery of their salaries, which were not defended, so that they got their money and the others did not. The Governor was greatly blamed for the part he took in that proceeding. Although they were very far from having solved the enormously difficult and delicate native question, he thought in regard to what might be called constitutional issues they had arrived at calm water, and it was most unlikely that any serious prolongation of difficulties, caused by the differences between two assemblies in a colony, and any proposed intervention by the Governor in such a dispute, would be seen. The prerogative of pardon was a question which

had sometimes led to most difficult and complicated transactions. Guernsey was not a colony—it was a kingdom which claimed to be one of two kingdoms now representing the Duchy which conquered England, and to which the Crown of England had become annexed. In Guernsey, the question of the power of the Crown to pardon a prisoner was disputed to such a point that he would advise all those interested in the subject to obtain a copy of that most interesting plaidoirie of Mr. Haldane's, which was to have been pronounced on behalf of the States if the case had ever come to trial. The Crown took the law into its own hands; it broke prison; it landed a foreign subject on foreign soil, and the public heard nothing about it because the case was never tried. Those subjects were invariably of the gravest delicacy, upon which the Crown was driven in some cases to act even against the wish of the local community in order to avoid war with a foreign power. Under the heading of "Trade Relations," there was a discussion on the interesting subject of the commercial and trading power of the colony to have its own way even against the interests of the Mother Country. Besides the example the author gave, there was the very interesting case of the Reciprocity Treaty between Canada and the United States. There was also the still more notable case, though less important in itself, of the Customs Union, which brought the Cape and the Orange Free State, then an independent republic, into a Customs Union, with the support of the Colonial Office but against the violent protest of the Foreign Office and the Board of Trade. The law passed the Cape Parliament, and the whole question was discussed very freely, with the curious result that the Departments took opposite views upon that most interesting question of Colonial power. Canada, as the author had said, was now associated with the treaty-making power to the point that, subject to one implied or understood reservation, Canada now made her own treaties for herself. Since Sir Alexander Galt was virtually allowed to do so in Paris in 1881, she had obtained in actual theory that which at that time was a mere matter of complaisance; and although some people in Canada still asked for the absolute treaty-making power which, personally, he thought it was somewhat difficult to concede, nevertheless in practice they appeared to be satisfied with the result of the present system. The only other subject which he thought it necessary to raise, was closely connected with the question he had been discussing, namely, that which involved the interference of the Home Government with the views of the colony of Newfoundland. Throughout the paper, while the author had invited the audience to discuss them, he had carefully avoided what might be called the burning questions of current politics, and very properly so as an official in a great office; but he mentioned very fully, in the paper, the neglect of consultation with the Newfoundland Government in connection with the *modus vivendi* that arose with regard to the Fisheries in 1891. As a fact, the case was somewhat similar to the recent one, where an arrangement was concluded with the United States for a *modus vivendi*, against the partial protests, at all events, of the Newfoundland Government, and certainly without their concurrence, in violation as was said of the principle laid down by Mr. Labouchere as Secretary of State for the Colonies a great many years ago, which was called the Charter of Newfoundland Liberties. In the recent case the Government justified themselves by the continued existence of a Statute of 1819, which ran directly counter to the principle laid down in the author's paper, and which was the sole ground, so far as he knew, upon which the action of the Government could be justified. In another case which interested the two Australian representatives present, namely, the New Hebrides, the colonies were not consulted in advance in regard to the arrangement which was made. He believed Mr. Deakin stated at the Colonial Conference that he first heard of the matter from Paris in the first week of December, just when the late Government went out of office and the present Government came in. At that mysterious moment, when there could hardly be said to be a Government in office at all, the arrangement was virtually concluded, and it appeared at full length just as it was officially signed, in a newspaper in Paris. Therefore the consultation in that case was an after-thought following upon the proceedings of December, 1905. On the general doctrines of the paper he thought there could be no dispute. There was an interesting debate in Parliament, in the course of which Mr. Chamberlain, while denouncing in the strongest terms the action of Newfoundland in virtually selling all her assets to a contractor, not only railways but the Post Office and everything she had to sell, did not interfere with it; and if England did not interfere in such a case as that he imagined she would never interfere again in any case, except where, rightly or wrongly, she considered the interests of the whole of the Empire were deeply and profoundly concerned. Even that limited interference was a very delicate matter, and raised those terrible native problems, by an allusion to which he thought it necessary to begin his remarks.

The Hon. J. W. TAVERNER (Agent-General for Victoria) trusted that the paper would find its way into every room in the Colonial Office, and that under the new system of government good results would follow. The author had raised three important points, the first of which was the comparison he had made between the Governor of a colony and the constitutional King. He (the speaker) was in agreement with the Chairman, that there was a great difference between them, and that even the King would not in any way interfere with the rights of a self-governing colony. He would mention two cases to show how, in the old days, Governors were influenced not by the King but by the Colonial

Office, and in both cases in the very opposite direction, in order to illustrate the difficulties Governors sometimes had to face in carrying out their duties. In one particular instance, Lord Glasgow was told by the Colonial Office to carry out the advice of his responsible Ministers; and, in the second place, there had been a recent case in Queensland where the Governor (he did not know whether he was acting "off his own bat") ignored the advice of the constitutional Governor. He quoted those cases to show how, following the words of the Chairman, it was only where Imperial interests were at stake that the constitutional king would attempt to interfere with the aspirations of the people of a self-governing colony. The Chairman had referred to the ticklish question of the deadlock that took place in Victoria where the Governor was not in accord with the determination of the Government of the time on that particular question of policy, and properly declined to depart from that position. In that case the Governor suffered—being recalled; but such cases, as the Chairman stated, were not likely to recur in the future, because, if there was one thing that had been absolutely demonstrated to the people of this country, it was that the people of the Colonies could be trusted in the making of their own self-governing laws. He very much wished the discussion on the paper could be postponed, so that the Colonies might be able to put before the people of this country what self-government had done, was doing, and would do for the Empire, if the seat of the Empire realised the importance of keeping her colonies together. He had had twenty-five years of public life, and had been connected with three Governments; and he said, without any desire to be egotistical, that the Colonies had endeavoured, under the powers vested in them by the Imperial Government, to build up colonies that were loyal to the backbone to the Mother Country. Great commercial development had followed the development of self-government, a question which he was sorry the author did not touch in more detail. It was what might be called a by-product to the paper, and brought to the notice of the people of this country our great colonies and the credit that was due to the pioneers who developed them. The Colonies had been so mixed up in the past with Crown colonies that it had been a difficult matter for the Colonial Office to separate them; and he trusted, therefore, that a copy of the author's excellent paper would be put upon the desk of each official in the Colonial Office in order to show them the great results which had been achieved. He was positive great results would follow co-operation in carrying out the laws, if the governments in the respective colonies were trusted to frame laws for the best interests of the people they represented.

The HON. J. G. JENKINS (Agent-General for South Australia), endorsed the remarks Mr. Taverner had made on the fact that a gentleman connected with the Colonial Office had written such an excellent paper. He endorsed the suggestion that a copy of the paper should be placed upon the desk of every official in the Colonial Office, or the Imperial Office to give it its full title; but he would be better pleased if some power of compulsion could be exercised to make them read, learn and inwardly digest the good things in it. In dealing with the natives in outside parts of the Empire, he believed that Australian people often misjudged the difficulties of those in Africa and India; Canadians misjudged the difficulties in Australia, and the people of England misjudged them all. He said that with no disrespect to the people of this country because it was impossible for the people living in the outlying parts to properly judge every detail of the work. In the same way, it was equally impossible for the people in this country to judge of the relations between a ministry in Natal, Australia, or British Columbia, in dealing with the native question there. For that reason, a considerable amount of latitude must be allowed in considering the positions taken up by various ministries which had the administration of the different countries dealing with the question. With reference to the question of the powers of governors, at the present day, owing to the reconstruction of Colonial sentiments in Great Britain, there was much less likelihood of difficulty arising between the governors of responsible colonies and Crown colonies than there was in times gone by. As the author had pointed out, it was not now a question of sending the relatives and younger sons from England, for England's good, to administer the affairs of the colonies to the detriment of the colonies, and for that reason there was not the same danger of trouble arising between ministries and governors. He had served for 12 years as a Minister of the Crown, and for several years as Premier, and he could only think of two occasions when there was a dispute between the ministers and the governors. They were not on the point of the governor acting contrary to the advice of his ministers, but on that of governors making speeches practically touching on colonial politics, which were outside of the sphere for which they were appointed by the British Crown. One of the instances occurred through a governor being made the governor of a responsible colony after he had served for many years as the governor of a Crown colony, where practically he advised the ministers, and coming into a State where his ministers advised him, he did not at first see the distinction. Later, however, everything went smoothly. He was sorry the author had not referred in his paper to the difference in relation between the States of the Australian Commonwealth and the provinces of the Dominion of Canada. It was very difficult to make some officials of the British Government see any distinction whatever between a Canadian province and an Australian State, but there was a great difference. In Canada all the power not directly specified and handed over to the provinces was vested in the Dominion; in Australia all the power not prac-

tically specified and handed over to the Commonwealth was vested in the State. He suggested that the paper be not only distributed among the members of the Colonial Office, but to every member of the British House of Commons, because when those gentlemen discussed Colonial matters he thought it would sometimes be an admirable thing if they had a text-book to refer to which would give them an opportunity of talking more by the book.

Mr. ARTHUR POLEY said his interest in the Colonies was a very old one, as he was an Imperialist as soon as he was anything, and later it had been his fortune to be engaged professionally in Colonial Privy Council cases. The voice of the historian was present throughout the reading, but personally he confessed he would have liked to have listened to some of those philosophical deductions from the past which historians occasionally delight in for the profit of humanity. The real point he wished enlightenment on was not the process of development of government during the nineteenth century, but what was to be the process of development of government during the present century. The past was studied in order to ascertain future tendencies and movements of ideas. While, hitherto, they had seen in the Colonies men seeking above everything for the fullest freedom from all control, it was not quite so clear that the present century might not inaugurate a new state of things when the Colonies would seek to take their portion in the government of the Empire, whose children they were. It was because such ideas were living and present ideas in the minds of men that they desired that the Colonial Office should extend its point of view. The Colonial Office might understand history, but he could not help thinking that sometimes it was very seriously lacking in imaginative qualities. He thought such a paper as the author's, full of historical facts, might lead to a little more serious thinking and appreciation of some of the problems of Greater Britain, which were bound to come up for settlement in the near future.

Mr. F. H. M. CORBET said that in various parts of the paper the author had made interesting references to representative government as leading up to self-government. He desired to express the hope that the author might find time in future to write a paper on the development of representative government in the colonies, a subject about which little was known in this country. He was afraid it was looked upon as something of a very undesirable character, whereas, as a matter of fact, it must in a great many places be long established first if the benefits of self-government were ever to be widely accorded. He ventured to say it was not only those colonies which were almost exclusively occupied by English people that should enjoy the rights of self-government, but that self-government ought to be the aim in view everywhere in the distant, if not in the near future; and the more was known about representative government, and the more widely its benefits were extended, the better for the Empire as a whole. He hoped that the author would deal with representative government not only from the Colonial Office point of view, but also treat of its value in training the people for a wider franchise.

The CHAIRMAN, in proposing a hearty vote of thanks to Mr. Keith for his most admirable paper, said that the author's position was one of peculiar authority in the subject on which he had written. He was a very brilliant Oxford man; indeed, he believed Mr. Keith was acting as Professor of Sanscrit at Oxford at the present moment, which showed how great his scholarship and knowledge of matters outside the scope of the paper was. The real difficulty of the question was that the British Empire was, and always would be, mainly an Empire of black and coloured people, and it was impossible to have only the white self-governing colonies in mind when dealing with an Empire of that kind.

The resolution of thanks was then put and carried unanimously.

ELEVENTH ORDINARY MEETING.

Wednesday, February 19th, 1908; CHARLES HERCULES READ, F.S.A., Keeper of British and Mediæval Antiquities and Ethnography in the British Museum, in the chair.

The following candidates were proposed for election as members of the Society:—

Coldwell, Christopher Benjamin, Lucknow Waterworks (Aish-Bagh), Lucknow, India.

Dudhoria, Bijoy Sing, Azimganj, District Murshidabad, Bengal, India.

Irving, Joseph, Assoc.Inst.M.M., the Mono-Baltic Mining and Smelting Company, Ironton, Colorado, U.S.A.

Kincaid, Major-General William, care of Messrs. Alexander, Fletcher and Co., 2, St. Helen's-place, E.C.

Leighton, Professor Gerald Rowley, M.D., C.M., F.R.S.E., Sunnyside, Russell-place, Trinity, Edinburgh.

Lewkowitsch, J., Ph.D., M.A., F.I.C., 71, Priory-road, N.W.

Runton, Percy T., A.R.I.B.A., Victoria-chambers, Bowlalley-lane, Hull.

Sanderson, Sir Percy, K.C.M.G., 65, Wimpole-street, W.

The following candidates were balloted for and duly elected members of the Society:—

Allison, John William, R.B.A., Havelock-villa, Outram-road, Portsmouth.

Carey, John G., Council-house, Hounslow.

Davis, Alfred A., A.M.I.E.E., corner of Kapteyn and Banket-streets, Hospital-hill, Johannesburg, Transvaal, South Africa.

Duncombe, H. F., the Bournemouth Hydropathic, Bournemouth, and Constitutional Club, Northumberland-avenue, W.C.

Empain, Baron Edouard, 33, Rue du Congrès, Brussels, Belgium.

Gordon, John William, 11, King's-bench-walk, Temple, E.C.

Henry, Dr. Thomas Anderson, The Scientific and Technical Department, Imperial Institute, S.W.

Keith, Mrs. Margaret S., 26, Norham-road, Oxford.

Leigh, Evan Arthur, 33, Brazennose-street, Manchester, and 232, Summer-street, Boston, Mass., U.S.A.

Merritt, H. Sydney, 13, Hans-place, S.W.

Pennington, Arthur Reginald, The Court-house, Axim, Gold Coast Colony, West Africa, and Kilty Crag, Grasmere, Westmoreland.

The CHAIRMAN, in introducing the reader of the paper, said the subject of the Law of Treasure Trove was of more general interest than the world at large supposed. It might affect any individual, as he knew feelingly from personal experience in past times, although he would endeavour to take care that it did not do so in the same manner in the future. He was sure the audience would be much interested in the paper, both as to the law itself, which was somewhat curious, and as to its application, which might sometimes be thought rather illogical.

The paper read was—

THE LAW OF TREASURE TROVE.

By WILLIAM MARTIN, M.A., LL.D.

For two reasons it is fitting that suggestion for reform in the law of treasure trove should be laid before this Society for discussion. In the first place, the preservation of articles of antique workmanship subserves the artistic crafts in a manner that is unnecessary for me to elaborate here; in the second place, this Society has always interested itself in reform which is associated in any way with the progress of the Arts. No more, I think, need be said in justification of the introduction of a paper upon the reform of the law of treasure trove. I will therefore pass immediately to my subject.

From the earliest times history is resonant of search for hidden treasure and of the joy evinced upon its discovery or, rather, the disappointment which more often has attended the expenditure of labour and money in the attempted recovery of supposed treasure. Even at the present day, judging from newspaper accounts, the expectation of the finding of hidden gold and silver appears to be as vivid as ever. There seems scarcely to be a castle, mound or monolith but which, for some, contains treasure deposited in times long ago. Owing to conflicting interests that must have arisen in the disposal of recovered treasure, regulations and laws have been made in all civilised countries from the earliest times. In England, in particular, we may read how, for centuries, interest has been evinced in the discovery of wrought gold and silver and in the steps which have been taken to secure its proper disposal. That treasure is being brought to light in various countries of the world should not excite surprise. Apart from historic instances of the loss or deposit of treasure, the gratification of the hoarding instinct of mankind has always been a fruitful source of discovery. To take a recent instance, Lord Cromer informs us that in Egypt alone some £1,500,000 or £2,000,000 have annually been converted into jewellery, and that hoarding has been carried on to an extent which is almost incredible to Europeans. His lordship also gives three instances where a little while ago the sums of £80,000, £25,000, and £5,000 respectively were found to have been hoarded.

In spite of banks, trading corporations, and other business concerns which may profitably employ the precious metal, there appears always to have been a percentage of suspicious or cautious individuals who have preferred the physical retention of their gold to becoming creditors to the same amount. Only a few months ago we were the witnesses of the transference to America of vast sums of bullion to allay financial stress. We were told that big speculations in copper and others things had led people, with the view to hoarding, to withdraw gold from trust companies and banks, and that when the Americans ceased to hoard, the deadlock in financial circles would be at an end. It is not unreasonable to presume that a proportion of this hoarded treasure will remain hidden indefinitely. What has happened in America might also happen here, granting the same financial conditions. The secreting of hard-earned savings by misers is also in point. We may, therefore, suppose that the ancient practice of burying gold for safety is still pursued, and will continue to excite both the cupidity of those desirous of its recovery and the jealousy of those who have not been fortunate enough to discover hiding places.

On all sides the opinion is freely expressed that it is little short of iniquitous for the Crown to step in and to dispossess a finder of articles of precious metal, articles which previously were unknown to exist, and which in consequence had not been the subject of conscious possession. An appeal is sometimes made to the doctrine "Finding's keeping," as though the mere fact of physical detention of ownerless or derelict articles carried with it the rights of and was equivalent to complete ownership. As between the owner of the land upon which a find is made and the Crown, the following views of a professor of law may be taken as typical:—

"The rights of the Crown as against the owner of the land are a manifest injustice, descending from feudal doctrines practically obsolete, and ought not to be kept up merely for the purpose of directing finds to public repositories."

A celebrated excavator and antiquary writes that:—

"From past ages the English law has claimed for the Crown all treasure accidentally discovered. Such a law is the best way to ensure that no such discoveries are made known and to drive the finder to put all such treasures in the melting pot." (Petrie's *Methods and Aims in Archæology*, p. 183.)

On the other hand, the law of treasure trove, as it stands to-day, rarely receives its mead of praise. To the author of the present paper, the wide-spread condemnation of the law appears to be founded upon an inadequate perception of what the state of affairs would be in the absence of the law of treasure trove. To avoid the evils which have been alleged against the law, not a lessening of its rigour is called for, but greater stringency and uniformity in its application, increase in its scope, and, what so easily could be accomplished without legislation, improvement in its administration. In fact, it is not less law of treasure trove that is required, but more.

The main object of the present paper is to show that by reasonable amendment in law and administration, individuals would gain, national and local museums be enriched, the arts advanced, and the development of the science of archæology assisted.

Since the law of treasure trove may conveniently be regarded in the nature of an exception to the law of first-finding, it would appear desirable, if not necessary, in order to appreciate its present condition, to advert to the law of first-finding. After having seen to whom ownerless articles when discovered belong, and when the rights of ownership may be exercised by the finder under the law of first-finding, the exceptions which the law of treasure trove introduce can then be more easily understood, and the suggestions for amendment in conformity with the spirit of the times be more readily submitted. It should be noted that the law set out in this paper refers only to England and Ireland, and does not include the law of Scotland.

Considering the length of time that law relating to treasure trove has been in existence, it is a matter for surprise that so few judicial decisions have been recorded, and that a mature body of case-law has not yet been developed. The Year Books, dating from the time of the Plantangenets to the Tudors, contain but two or three references to the subject, while the one statute only, if statute it be, that alluded to finding of treasure, was concerned with the duties of a coroner. Bracton, Fleta, and Britton all give definitions of treasure trove, as understood in their days, and the penalty to be inflicted upon unlawful appropriators. Bracton's definition in the time of Henry III. was as follows:—

"Est autem thesaurus, quædam vetus depositio pecuniæ, vel alterius metalli, cujus non extat modo memoria, ut jam dominum non habeat," &c. (1, iii., cap. 3, f. 4.)

This definition appears to have held good for some centuries. In the Institutes of Coke which were published at the commencement of the seventeenth century, Coke's definition, which is given below, will be seen to differ in respect of the limitation of *thesaurus* to articles of gold and silver only, from Bracton's, which indeed is but a transcript from the Roman law. Since the Stuart period Coke's, definition has governed all attempts to state with precision the characteristics of treasure trove. The Law Reports, to which one naturally turns for exposition of the law are disappointingly sterile, perhaps some five or six cases only appearing which deal with the subject. The result is that, with exception of an administrative measure, which will be given at length later, the law and the rules governing treasure trove have not advanced to the extent that is desirable.

With this introduction I will proceed at once to set out as briefly as possible the law of first-finding in so far as it concerns the destination of the articles which have been discovered, and of which the true owner cannot with reasonable diligence be traced.

Although a finder has rights which are due simply to the fact of physical deten-

tion, rights which are sufficient as against another who cannot show a better title (Armory *v.* Delamirie [1722] 1 Str. 504), yet by no means does it follow that he becomes in the absence of all knowledge, actual or constructive, of the true owner, entitled to possession for an indefinite period. In some cases the finder may become the owner, but probably in the greater number of cases he has no rights of ownership. The person who by the law of first-finding is the owner depends, in any particular case, on a variety of circumstances. These circumstances may be indicated by reference to two or three typical cases which have been dealt with by the courts. In briefly setting out these cases, I will, if you will allow me, draw upon some notes which I published a little time ago, on the law of first-finding. The chief of the conditions which determines ownership in a mere finder, or in another, depends upon whether the place where the article has been found does or does not belong to the finder. In a case decided in 1896, when two gold rings had been found by a labourer in cleaning out a pool, Lord Russell said:—

"The general principle seems to me to be that where a person has possession of house or land, with a manifest intention to exercise control over it, and the things which may be upon or in it, then, if something is found on that land, whether by an *employé* of the owner, or by a stranger, the presumption is that the possession of that thing is in the owner of the *locus in quo*." (South Staffordshire Water Company v. Sharman, L. R. [1896] 2 Q. B. 47).

Manifestly this ruling considerably limits the number of cases where a mere finder is entitled to his find.

On the question of the ownership of a prehistoric boat which had been exhumed by certain lessees, it was settled in 1886 that the boat from its relation to the soil in which it was embedded was the property of the lessor as owner of the soil, and that the lessees did not acquire any property in the boat by the mere act of finding. From this decision, and the accompanying remarks of the Judge, it is clear that neither a lessee, nor a mere finder, or excavator, is entitled to buried relics of antiquity. The case which is probably the most favourable to the finder is when property has been lost on the highway, or in a shop to which the public has had access. In 1851, it was held judicially that a shopkeeper did not have a greater right to a number of banknotes which had been dropped on the public side of the counter, than the individual who picked them up (Bridges v. Hawkesworth [1851] 21 L. J Q. B. D. 75). The ground of the decision was that the notes, having been dropped in the public part of the shop, were never in the custody of the shopkeeper, or "within the protection of the house."

There are also several other cases, civil and criminal, from which, with those alluded to, we may conclude that, in most instances, it is truer to say that a finder may not retain what he finds, even when the owner is unknown, since the articles found, in virtue of their situation and of the other circumstances in which they have been discovered, usually belong to another.

When the find consists of the precious metals, gold and silver, more powerful claimants than the landlord may appear, viz., the Crown or the Crown's assignee. When gold or silver is surrendered in these instances the action is usually not due to the law of first finding but to the law of treasure trove. In passing it should be noted that by a statute of 1901 (1 Edw. VII., c. 4), the Civil List Act, the hereditary revenues of the Crown, among which is treasure trove, were directed to be paid into the Exchequer to form part of the Consolidated Fuud. Treasure trove, therefore, no longer in fact reaches the Sovereign, but is subject to the control of the Government. For convenience, however, we may continue to speak of the Crown as the owner of treasure trove.

As regards the characteristics of treasure trove and the manner in which treasure trove differs from other finds, we will now turn to Coke's definition which is as follows:—

"Treasure trove is when any gold or silver, in coin, plate, or bullion that hath been of ancient time hidden, wheresoever it be found, whereof no person can prove any property, it doth belong to the King, or to some lord or other by the King's grant or prescription." (3 Inst. 132).

This definition, which is often appealed to, has on several occasions received judicial and official approval. Difficulties are, however, raised by its wording. With the full knowledge of the hazard run in attempting to frame definitions—owing in part to the impossibility of foreseeing all cases which may require to be judged by a definition, or the purposes for which a definition is required—yet it seems that treasure trove may be more concisely and comprehensively set out by saying that—"Treasure trove consists of gold or silver advertently deposited anywhere without abandonment, the owner being unknown."

This definition, among other things, avoids the use of the equivocal term "to hide" or "hidden," terms which may mean either a depositing out of sight without the knowledge of others, or a depositing out of sight with their knowledge. On the other hand, it includes, it is submitted, the essentials of treasure trove in so far as the subject has received judicial interpretation. There must be, if the definition is correct, an advertent deposit of precious metal. Consequently, when an article has been abandoned or accidently lost, its disposal, when found, will not be governed by the law of treasure trove, but by the law of first-finding. Thus, if a single coin were found in a ploughed field, it would be fair to presume that the coin had been lost accidentally. Its proper destination would therefore be determined by the law of first-finding, and, in consequence, it might be lost to the public. Further, the idea associated with an advertent deposit also includes the intention of reclamation at some future time by those who deposited the treasure. Therefore, articles abandoned or coins scattered as gifts would not be treasure trove, since, in these instances, there would be no advertent deposit. But what does, or does not, in fact, constitute treasure trove is not this evening of primary importance, the main object of the paper being, as already premised, to show how urgently amendment in the law and its administration is required, and how this may be done with a minimum of disturbance of vested interests.

To those who consider that the law of treasure trove is an anachronism, unfair, or even inexpedient, the question may now well be asked whether a complete abolition of the law would result in a better condition of affairs. To deal with this question, we may compare the position of a finder under the law of treasure trove as at present administered with that of a finder under the law of first-finding. When metal has been advertently deposited, there is but little chance of its finder being able to show that under the law of first-finding he is the true owner. In the absence of a special law to the contrary, the owner of the soil is entitled, in the absence of contract, to all the soil contains, whether the nature of its contents is or is not known. The instances of the prehistoric boat and of the two gold rings have already been given where the ownership lay in the owners of the soil. It perhaps would not be too sweeping to say that in no instance would treasure trove, if governed by the law of first-finding, belong to a mere finder as such. As part of the soil it would belong to the landlord, and in this respect the fact that the Crown steps in and appropriates treasure trove does not affect the position of the finder.

Let us now consider the position of a finder as regards reward that he may receive as the result of his discovery. The owner of the soil may or may not reward the finder. There is no legal compulsion, although possibly moral suasion might have its effect. That no reward is promised, or will not be given, does not vary the fact of ownership or permit a retention of the find until a reward is offered. As regards treasure trove and the Crown, after some experimenting with the view to preventing the continuous leakage of treasure trove, the Home Office, in the year 1886, issued the following circular letter in which promises of remuneration to finders were set out:—

Whitehall,
27th August, 1886.

SIR,—I am directed by the Secretary of State to acquaint you that the Lords Commissioners of the Treasury, being desirous to render as effective as possible the assistance which is given to the efforts of Antiquarian Societies for the preservation of objects of general interest, by the assertion of the claim of the Crown to coins and antiquities coming under the description of Treasure Trove, have reconsidered that practice, as intimated to you in the Circular of 15th July, 1871, of paying to the finder of articles of Treasure Trove, on behalf the Crown, the full bullion value of such articles.

Their Lordships, with a view to encourage the finders of coin and ornaments to notify the fact of their discovery to the Government, are ready to modify their existing regulations; and to return to the finders, who fully and promptly report their discoveries and hand over the same to the Authorities, the coins and objects which are not actually required for national institutions, and the sums received from such institutions as the *antiquarian* value of such of the coins or objects as are retained and sold to them, subject to the deduction of a percentage at the rate, either

1. Of 20 per cent. from the antiquarian value of the coins or objects retained; or,
2. A sum of 10 per cent. from the value of all the objects discovered, as may hereafter be determined.

This arrangement is tentative in character; and the complete right of the Crown, as established by Law, to all articles of Treasure Trove is preserved.

I am to request that you will have the goodness to make this alteration in practice generally known,

more especially to Pawnbrokers and other similar dealers within your jurisdiction.

I am, Sir,

Your obedient Servant,

GODFREY LUSHINGTON.

It is understood that the promises contained in this letter still hold good. Although the promise of the Treasury to reward finders is purely voluntary and "tentative" only, yet the promise of a high department of the State approaches the uniformity and strength of a law. From this circular letter, we see that the finders of treasure trove have been promised a reward which may equal 80 per cent. or more of the antiquarian value of the find. No mention is made of pecuniary or other gift to the owners of the soil in which the find occurred, the promise of reward being directed to the finders only. Finders then are by the operation of the law of treasure trove in a superior position to that under the law of first-finding. Even in the possible, but exceptional case, where a finder becomes owner, it is rare that a finder realises as much as 80 per cent. of the antiquarian value of his find. Usually the selling price is far below this. The proverbial pot of beer is of potent influence in effecting an exchange.

Under the law of treasure trove the finder is compelled to hand over the articles; but he receives pecuniary compensation, and this compulsory substitution of money for the articles of which he usually is not the owner is the extent of his hardship. I submit, then, that in the great majority of instances, the finder under the law of treasure trove is in a superior position than under the law of first-finding.

Next, let us consider what is the gain from the point of view of the public, and of historical and archæological research when the Crown secures possession of treasure trove. Treasure trove, so far as can be ascertained, is offered on sale to the trustees of the British Museum, and, if accepted by the trustees, is placed in the show-cases, where it may be viewed by all. At the present moment there are many examples of treasure trove at the British Museum. In a notable case, the Albert and Victoria Museum at South Kensington profited by a refusal of the British Museum. Duplicates of objects, such as coins, are, it is believed, transmitted to local museums, while those which are not required for public exhibition are returned to the finders. Thus a knowledge of the existence of treasure trove is disseminated and the articles are made available for study and enjoyment, with a minimum of restriction. In addition, they are usually examined by experts and the results published. In the case of finds which belong to private individuals, at the best they are voluntarily exhibited in public museums. At the worst the value to the owners is the value of the bullion contained in them, and their destiny is the melting-pot. They may, however, pass to private museums, where their utility is greatly diminished either by the ignorance of the public as to their existence, or by the inability on the part of the public of access to the private collections. Often as not, relics are transferred from hand to hand, so that their identity with the site where they were found or the circumstances in which they were discovered, is forgotten, with the consequent loss to archælogical science.

I am aware of the feeling that attaches to the ownership of an article for which no ordinary sum of money may be compensatory, and that to deprive one who, in the absence of a law of treasure trove, would be owner, of his right of property, may in some exceptional instances savour of confiscation. Still, even if such a case could not be dealt with satisfactorily by administrative officers, the balance of advantage would seem to be in favour of a strict preservation of treasure trove in positions accessible to the public. Of course it must not be forgotten that when land has been purchased or otherwise acquired, the transference has always taken place without the treasure trove that exists undiscovered, unless indeed the Crown has assigned its rights. It has also been alleged that the proper place for the exhibition of relics is in a museum situated within the locality in which the relics have been found, and that relics lose in interest when dissociated from their original surroundings. Consequently it is said that the Crown's abstraction of treasure trove from the locality of its discovery is to be deprecated. Although there may be something in favour of this view, yet it is rare that treasure trove is indigenous to the locality of its exhumation. If it were, then local exhibition might be provided for by giving the necessary power to the officials to whom the preservation of treasure trove was allotted.

In some instances, the right to treasure trove has been assigned by the Crown, with the result that on a find taking place, the Crown's assignee becomes its owner. In such a case, the exception which the law of treasure trove introduces into the law of first-finding is

removed, and the incidental evils of the law of first-finding brought back again. Where the right to treasure trove is vested in private individuals, the owner, after having gained physical possession of articles which may have been found, would be legally entitled, if he thought fit, to sell or to retain the articles. He might if he chose destroy them capriciously, or cast them aside thoughtlessly. Even when relics, in private hands, are diligently cared for, they are often, as far as the public is concerned, as good as lost. In private collections, their value is, from an educational point of view, much diminished. For instance, in 1777 we find the Vicar of Headley writing to Gilbert White, of Selborne, saying—

"And this is the misfortune of most antiquities and curiosities, that they frequently fall into hands that can collect nothing from them; in whose coffers they are more buried than if they were to lye in the depth of a mine, or of Wulmere pond." ("Life, &c., Gilbert White," by Rashleigh Holt-White).

Still in any suggested extension of the law, the rights of assignees from the Crown would have to be considered, and to be purchased on behalf of the public at a proper valuation. The suggestion is, of course, that in each case the article should be acquired by the Crown, suitable compensation being awarded.

There is a curious survival from the times of Edward I. and earlier, of a coroner's duty to hold an inquest upon treasure which had been found. By the statute *De Officio Coronatoris* (4 Edw. I., St. 2) of 1276, a statute which has been characterised as apochryphal, "a coroner ought also to enquire of treasure that is found, who knew the finders, and likewise who are suspected thereof." This statute continued in force till the year 1887, when the following section of the Coroners' Act of that year was substituted. By section 36:—

"A coroner shall continue as heretofore to have jurisdiction to inquire of treasure that is found, who were the finders, and who suspected thereof, and the provisions of this Act shall, so far as consistent with the tenor thereof, apply to every such inquest."

In spite, however, of the clear wording of these statutes, coroners have been in the habit not only of inquiring "of treasure that is found, who were the finders, and who suspected thereof," but also ot obtaining from a jury, which has been empanelled, whether a particular find is or is not treasure trove, and, as a result of that verdict, seizing the alleged treasure trove on behalf of the Crown. As a high officer of the Crown, a coroner has the right to retain treasure trove upon inquest or otherwise, but whether he has any jurisdiction to instruct his jury to deal with a complicated question of law, and to lay down whether a particular find is or is not treasure trove, is another matter. Such jurisdiction is clearly not to be obtained from the wording of the statute. Coroners have also alleged a right to any treasure that is found, in much the same way as they claim a dead body, and have threatened penalties against those who, in good faith, believing themselves to be the owners of the find, have refused the demand of the coroner. The coroners' contentions in these particulars do not appear to be well founded. Indeed, the case of the Attorney-General v. Moore (1893, 1 Ch., 676) shows that a coroner is not empowered to settle questions of title to treasure trove. In practice, however, this case has not by coroners been considered as ousting their jurisdiction to decide, by the aid of a jury, whether a find is treasure trove, and to demand the physical transference to them of a find, even though there may be involved *boná-fide* questions of the right of ownership.

It is, however, fair to remark that the inquest which was held last year by the coroner upon the hoard of Roman bronze and copper coins discovered at Weybridge was of utility as regards preservation of the find.

As we have already seen, treasure trove is confined to articles of gold or silver. Articles of bronze, brass, copper, and, in general, of the base metals are excluded. From the point of view of national benefit, the law which brings to the Crown gold and silver should be extended so as to include hoards of other metals. The inquest at Weybridge shows that such an amendment would result in a practical measure. Thus, the coroner at Weybridge succeeded in calling up the major part of those coins which had been scattered, with the result that after a little delay, due to circumstances which need not be referred to, the hoard was acknowledged to be the property of the owner of the soil on which is was discovered. To bring within the scope of the law all metallic articles would merely be reverting to what Bracton, centuries ago, considered was covered by the word, *thesaurns*.

Some antiquaries in their zeal for archæological research, would requ.re all newly found articles, of not less than a certain age, whether metallic or otherwise, to be handed over to the Crown. Presumably the absence of knowledge of the existence of the articles should be sufficient according to their views to deprive

the landlords of their ownership. There would be, however, such practical difficulties in bringing about so radical an alteration in the law as to render it undesirable in the first instance to press an extensive amendment of this character. More modest proposals would be preferable. The better suggestion is to include all metallic articles, of which the owners were unknown within the scope of the law of treasure trove. As regards the ownership of precious metals, which are found in sepulchral mounds, it is remarkable that the law reports are silent. If the definition of treasure trove, which has been submitted in this paper, be a true one, the contents of sepulchral mounds would undoubtedly fall to the Crown. If, however, the idea of reclamation is indissolubly associated with treasure trove, it can hardly be said that precious metal buried with human bodies is treasure trove. Similarly as regards offerings cast into a well for the propitiation of saints or unknown deities. They have been thrown away, not as largesse, so as to become the property of their first appropriator, nor with the view to reclamation at some future time. Whether in fact such votive offerings constitute treasure trove still awaits judicial pronouncement.

For those who would wish greater stringency in the law, so that valuable relics may be preserved for the edification of the nation as a whole, much hope may be derived from passages in the judgment in the case of the Attorney - General *v.* the Trustees of the British Museum ([1903] 2 Ch. 598), passages deserving of the closest attention. Mr. Justice Farwell, before whom the question was raised whether certain gold articles found in the north of Ireland constituted treasure trove said—presumably in allusion to arguments by counsel :—

"The Crown must first prove a *primâ facie* case, but when they have done so, the defendants must defeat that title by producing a better title."

At the conclusion of the judgment his lordship remarked :—

"It is also unnecessary for me to express any opinion on the last point urged by the Attorney-General, which is of considerable importance—viz., that in all claims to property, the Crown is entitled to treat the defendant as if he were plaintiff, and to insist that he must succeed on the strength of his own title, and cannot defeat the Crown merely by showing that the Crown's title is bad."

From this it is fair to assume that, in the opinion of the Treasury, the law was correctly expounded by the law officer of the Crown. If this opinion should be judically accepted in the future, it would result that when treasure trove is alleged to be in the possession of an unauthorised person, such an one will have to prove that the articles in question were either not advertently deposited, or else show that they were abandoned or accidentally lost. It is needless to remark how hopeless would be the position of the majority of defendants in such a case. The result would be that articles of precious metal would in most cases be held to be the property of the Crown.

That the law relating to treasure trove is not uniformly applied or is evaded is common knowledge. One has only to visit public museums where gold and silver articles are exhibited, and to see how these articles, which, to all appearance, are treasure trove, have been purchased or received from private holders. In addition, the papers read before antiquarian and numismatic societies, concerning hoards of coins and of other articles of precious metals, show how sporadic—one is almost inclined to say, capricious—is the application of the law. Isolated actions for the recovery of treasure trove are productive of much harm by giving rise to the feeling of injustice for special individuals having been singled out as examples. Were it understood that in every case efforts would be made to recover for the nation treasure trove and that the finders would be liberally rewarded, there would scarcely be a learned society or a right-thinking person but would lend its or his hand towards the preservation or delivery up of treasure trove.

It is unfortunate that the police have been, and are still, employed in the collection of treasure trove. Intervention by the police is apt to be resented. The knowledge that a call from a constable will follow "upon information received," is often sufficient for the unthinking to deny a discovery, and to hurry a find to the melting pot. Until the necessity is clearly apparent, it seems a mistake for the finder of treasure to be visited by the police, and to that extent be treated as a possible criminal. Civil functionaries should, except, perhaps, in extreme cases, undertake the temporary custody of precious relics, and should, where necessary, be empowered to set in motion in a friendly capacity the machinery for the settlement of questions arising from a discovery.

The absence of knowledge of the offer of the Treasury to reward finders of treasure trove, even among the educated classes, is

remarkable. The general opinion appears to be that when by some ill-defined right the Government secures, or confiscates, a valuable relic, the finder will hear no more about the matter. Apparently, to frustrate what appears to the many to be a high-handed action, the relic is more often than not secreted, sold, or melted down. To remove the ignorance which prevails as to the Treasury's offer to reward finders, it ought not to be difficult to provide means for the education of the public, so that on a relic being discovered, the hand of the destroyer might be stayed and the relic preserved for examination by accredited parties. In Ireland, the Royal Irish Academy has been in the habit of posting illustrated and other notices concerning the advantages to be derived by finders of "ancient articles of gold, silver, bronze, brass, or iron; crocks, coins, &c." In England, no action by a body comparable to the Royal Irish Academy appears to have been taken for bringing to the notice of finders the reward which may be theirs, or the duty which is incumbent on them to dedeliver up of what in fact is not their property. As a small measure of relief, "The South Eastern Union of Scientific Societies" has appointed, in conjunction with local societies, "referees" whom finders may approach for assistance and advice. The duties of these referees and the notices which they are desired to exhibit in places frequented by the public are set out in the following extract from a report for 1906 to "The South Eastern Union":—

"As supplementary to efforts towards the preservation of treasure trove and of relics of all kinds, it was considered advisable, if it were possible, to bring to the notice of those in districts who were likely to be finders, the importance of refraining from destroying articles of unusual occurrence that they encounter, or from selling them to a passer-by for the customary 'pot of beer.' Towards this end your committee has drafted a notice, simply expressed, for distribution within the area of the Union.

A copy of the notice is appended. Endeavours will be made, through members of the Union and others, to engage the sympathies of local personages and authorities, for instance, the officials of the County Council Schools, in bringing to the attention of the villagers' children, as well as the villagers themselves, the notices concerning treasure trove and relics.

Briefly, it is proposed to organise measures whereby the knowledge may be brought to every possible finder that it is to his advantage to know the rough value of what he finds before proceeding to dispose of it.

I this action of the Union should be in any measure successful, the arrest of the immediate destruction of relics will have been obtained, and their ultimate salvation more probably assured

Where vigilance is already extended by local antiquaries, curators, and authorities, action by the committee will, of course, be unnecessary in those localities.

* * * * * *

NOTICE TO FINDERS OF RELICS.

1. Finders of coins, trinkets, crocks, implements of old metal or stone, and other relics of old times, are reminded that the value of such relics is often greater than is usually obtained by sale to a passing stranger.

2. It is to the finder's interest to know the value of any such relics before selling them. Finders are, therefore, invited to apply for assistance in obtaining such information.

3. If the relics are of gold or silver, and are what is known as "treasure trove" the Government—as far as it has the power—has promised to give to the finders what is practically their market value.

4. On the discovery of relics, finders should immediately apply to Mr. of at who has consented to give what advice he can. This advice will be given gratuitously and in a friendly spirit.

5. It is unnecessary to clean the articles.

H. NORMAN GRAY, Honorary Sectretary,
Finds and Treasure Trove Preservation Committee,
South-Eastern Union of Scientific Societies,
334, Commercial-road, London, E.
Telephone, 7326 Central."

The bringing to the knowledge of the public the importance of the preservation of treasure trove, whereby not only the finders themselves would profit, but the nation would be enriched, ought not, however, to be left to private societies. Some definite government body, whose ordinary duties befit it for the purpose, should be expressly entrusted with the duty of preserving treasure trove, and should be empowered to act with alacrity when the knowledge of a find was communicated. The Board of Education, which for some years has had charge of the Science and Art Department at South Kensington, comes to mind in this connection. In analogy to the Patents Act of 1907, Sec. 46 (1), which permits the Comptroller of patents to issue periodically an illustrated journal of patented inventions, law reports, "and any other information that he may deem generally useful or important," the Board of Education might issue notices, documents, and such literature as in its opinion would tend to the preservation of treasure trove.

As regards remedial measures, the promise of the Treasury to remunerate finders should be converted into a Parliamentary instruction, with all the publicity incidental thereto.

On a recognised body assessing to the best of its ability the antiquarian value of a find, the reward to the finder should be fixed by Act of Parliament upon a liberal scale. Facts should be boldly faced, and it should be recognised that, owing to the present condition of the law, a very small proportion of treasure trove is recovered. Artistic and other relics are too often destroyed for the bullion they contain. If they had been preserved, their price as metal would have been small compared with the services they might have rendered to the arts, to a study of history, and to archæology. The loss of *amour propre* in the law must be propitiated, and the law which refuses to acknowledge expediency as a basis of change must be amended.

So far as the author is aware, no pronouncement of the Treasury has appeared since the year 1886, if we except the evidence that was given before the Treasury Committee, of 1898, to inquire into the circumstances in which certain Celtic ornaments, found in Ireland, had been offered for sale. Even copies of the circular letter of 1886, to which allusion has already been made, are not common. The Treasury deducts, as we have seen, as much as 10 or 20 per cent. from the antiquarian value of a find. Bearing in mind that by law the finder, as such, has no rights, except those of a bare possessor, this scale is eminently liberal, but from the point of view of the preservation of unique relics, the idea of no legal rights in the finder should be cast aside, and the position of the finder should be fully recognised by law.

To sum up the foregoing, it appears to the author that the existing law and administration fail to cope with the loss of relics of precious and other metal which is continually taking place, and that to protect the country in the future from the irremediable losses that have occurred in the past some amendment of the law is urgently required. As a basis for discussion the following is submitted :—

(1) An extension of the law of treasure trove so that the law may include all articles of metal, whether strictly satisfying the requirements of treasure trove or otherwise, and thus made to include metal relics whether abandoned, accidentally lost, cast away as votive offerings, buried in sepulchral mounds, or otherwise hidden.

(2) A statutory basis for the reward to be paid to the finder, with an intimation that, where desirable or expedient, the antiquarian value of the relic should be approached in assessing the reward.

(3) Where the owner of the soil participates by existing law in a find, compensation should be paid him in exchange for the article compulsorily given up.

(4) When the finder and the Government Office, which is specially selected to deal with all matters arising under the law of treasure trove, disagree as to the antiquarian value of a find, assessors should be appointed.

(5) Administration of the law of treasure trove should be transferred to a Government Department, such as the Board of Education.

(6) Statutory restriction of the functions of the coroner to those duties which by words appear in the Coroners' Act of 1896.

(7) In the case of a refusal to give up "treasure which has been found," the ordinary civil remedies should be employed in the same manner and to the same extent as when other property, in the absence of felonious intention, is retained. Threats and visits by the police, coroners' officers, or other functionaries endowed with jurisdiction, to be avoided as far as practicable.

With suggestions such as these in mind, a parliamentary or departmental committee could be appointed to report upon the practical steps which should be taken to prevent the continuing loss to the country of treasure trove and other relics of by-gone times, a loss which the existing law is, by common consent, unable to prevent.

DISCUSSION.

The CHAIRMAN (Mr. Charles Hercules Read, LL.D.), in opening the discussion, said the author had made a statement in the paper which would come as a surprise to the man in the street, viz., that when he found a thing there were four people to whom it might belong, the last of whom was the man who found it. They were the finder, the owner of the land, the grantee from the Crown of the rights to treasure trove, and the Crown itself, and in nine cases out of ten the Crown always held the trump card. When a thing was found which the Crown had claimed under the law of treasure trove, it was probably taken by the police or sent to them, and was then handed over to the Treasury, the solicitors of which informed the British Museum of the find, and it was sent to them with the request that they would report as to the bullion value and the antiquarian value, and state whether any of the objects sent were required, and if so, which. Those functions the British Museum performed, the objects being retained pending the decision of the Treasury with regard to

them. It might be of interest to the public to know that the Treasury took the whole of the control of treasure trove and the allocation of it, the British Museum having no control whatever. When the objects were of such a character as to be useful for the collections of the British Museum, they were retained, and their full antiquarian value paid to the Treasury. There were cases where the objects were more fitted for the collections at South Kensington than for the British Museum; and in the particular case the author mentioned, a find of silver of the seventeenth century was, at the instigation of the British Museum, passed on to the South Kensington Museum, which paid for it, he presumed, in the same way that the British Museum would have done. The author had stated that the finder received about 80 per cent. of the proceeds of the sale, the finder probably benefiting very considerably by that proceeding, because if the objects were sold to a dealer, he expected at least 20 per cent. profit, if not more, and therefore the finder probably received as much money from the Government, and in some cases a good deal more than from dealers. In that connection, the audience would probably remember the finds made by some men working gravel at Bexley, of two hoards of solid gold armlets or bangles, at intervals of about twelve months, which weighed nearly thirty ounces of almost pure gold. The British Museum paid between £200 and £300 for the objects; but the chances were that had they been sold in the neighbourhood to a silversmith, the man would only have obtained the bare bullion value, if as much as that. Quite apart from his own partisan attitude, he thought a good deal was to be said for the law of treasure trove even as it stood. The finder certainly benefited in all probability by obeying the law, and the community benefited because the objects were placed in public museums and were always at the disposal of any member of the public; whereas if they were sold privately they disappeared from the public gaze, and there was a great danger that the story of their finding might be lost. Apart from the bullion and archæological value of the finds, their interest to a museum was not the metal at all. Gold had always been the favourite metal of luxurious people at all times and in all countries, and therefore to have a collection of gold objects, even in a room apart, was not so illogical as it might seem at first sight. The gold room at the British Museum had a definite interest in itself, apart from the practical aspect of the custody of such objects, and that they must be taken more care of than if they were of less intrinsic value, the interest being in the fact that they represented the luxury of the period to which they belonged. The interest of the golden objects was, from the archæological point of view, not so much their intrinsic value as the facts connected with their finding. The interest of a find from the archæological standpoint was almost entirely in its preservation as a whole, and something might be said from that point of view for the author's suggestion that the law of treasure trove should be so extended as to comprehend objects which were not of the precious metals; but he did not see any practical advantage in it, except in perhaps one case out of fifty, where by means of putting the amended law into action, it would be possible to secure a kind of archæological unit by obtaining the contents of a hut dwelling, or grave, or whatever it might be. Although he was not a lawyer, it seemed to him that by no conceivable straining of the actual words of the statute, or by the interpretation of any judge, could the contents of a grave of, say, the year 600 B.C. possibly come within the law of treasure trove. The essential part of the statute was that the objects coming under it should be in the nature of intestate effects – *i.e.*, if a man died leaving an estate without any known heirs, under the common law of the land it went to the Crown. It seemed to him that the contents of a grave could not by any conceivable interpretation come under the statute, having been put there with a certain intention on the part of those who deposited them, that they should remain for ever with the body of the deceased friend. The mere words "treasure trove" seemed to him contradictory, seeing that the things never had been lost, and therefore could never be found by anybody. The author had not dealt with the law in Scotland, where there was another category of "waifs and strays" in addition to treasure trove, which included anything that was not of precious metal; and under the law the contents of graves were, and had been, claimed for the Crown. He demurred to the possibility of the contents of a grave, deliberately and carefully deposited, being interpreted as a waif or stray. The only reason he could suggest why the Royal Irish Academy took special steps for claiming and holding treasure trove in Ireland was that that body was the only institution in Ireland to which finds naturally went. In this country it was different, because they might go to the local museum, or the British Museum, or be handed to the owner of the soil. When he stated, in introducing Mr. Martin, that the law was scarcely logical, he referred to an instance that was in his mind of a very large cemetery of the Anglo-Saxon period, which was found in Warwickshire, and carefully excavated by the owner of the soil, who presented the whole of the contents of the graves to the British Museum. It came to the knowledge of the Treasury that in one of the graves was a little gold medallion, whose bullion value was 12s. or 15s., and this they took great pains to claim as treasure trove, although they put in no claim for anything else. It seemed somewhat illogical that they should do that, when it was perfectly well known to the Government that a vast number of collectors of objects of that class had in their cabinets articles which were treasure trove in the sense that the owner of them could show no legal title as against the claim of the Crown, had the claim been put forward. He thought the practical working of the author's suggestion, that objects which were not of precious metals should be

included under the present statute, would lead to objects being destroyed which were now preserved. The particular form of human nature which had to be dealt with in such matters as the finding of treasure trove was that found in the English navvy, who, rather than have any bother with the police, would be very prone to smash articles he found; whereas, if he got a shilling for them, they might be preserved, even if they were not kept with all the other objects with which they were associated at the time they were buried. Where the finder and the custodian of the Government disagreed as to the antiquarian value of the find, an assessor might be called in to say whether the Government valuation was a fair one; and in a recent case the assessor decided that the Government had erred on the side of generosity. A finder very often read accounts in local newspapers of his find rather than in the journal of archæological societies, and thought an object dating back to six or seven hundred years before Christ must be of very much greater value than an object dating back to 600 or 700 years after Christ. As a matter of fact, there was no such ratio of value, because an object of the tenth century might be more valuable than one of the first. The difficulty was to make a standing rule which would be just as between the finder and the Government nominee, but something practical might be done. The author had alluded to the fact that something should be done to inform the public at large in the widest possible way what the articles were and what the practice of the Government was with regard to rewarding finders of treasure trove. He had not much confidence in the Board of Education for this purpose, which had been suggested by the author, and thought a better plan would be for the County Councils to place in all the schools diagrams and coloured pictures, with short descriptions of the articles, to give the children an interest in them, and they would probably inform their parents when they saw such articles in the house. It was certainly a bad idea to import the police into the matter, such a subject as treasure trove having nothing to do with crime in the ordinary sense of the word.

Mr. F. W. RUDLER said that while originally he was in doubt as to the value of the ordinary law of treasure trove, he had come to the conclusion that the author was justified in suggesting an extension of present legislation. Those who opposed its alteration, based their view generally on the supposition that the present law led to a concealment in many cases of discovery, and in other cases to the consignment of valuable objects to the crucible. That could only result from ignorance, which ought to be dispelled if a knowledge of the conditions under which finders were remunerated was disseminated throughout the country. It had been suggested that the Board of Education should be the medium of publicity, but if the navvies were to be reached, possibly the best way would be to distribute circulars to every public house. Most of those present were not aware, until the Chairman made the remark, that the British Museum authorities gave the antiquarian value for the objects, but there was evidently some leakage in the passage through the Treasury, because only 80 per cent. of the amount reached the finder. That was an unfortunate deduction, because if a navvy found an object for which an individual would give him £1, while the Government gave him only 16s., the chances were it would find its way into the private person's collection. The curators of local museums might fear that the law of treasure trove acted unfairly to their institutions, they being naturally jealous if local objects went out of the district. There could be no doubt that, when an object was unique, its proper destination was the great treasure house over part of which the Chairman presided. As the golden armlets to which the Chairman referred were found at Crayford, their proper destination was clearly London; but supposing they had been found in Yorkshire, he could not help thinking that, as they were 17 in number, a selection might very fairly have been expected to be placed in the museum of the city of York. He thought the author had made out an extremely good case for an extension of legislation; but, at the same time, whatever the law might be, he thought it should be interpreted very generously by those who had its administration.

Mr. PERCY WEBB thought the Treasury practice was a little more liberal than had been suggested, because when they returned articles which they did not intend to buy they were in the habit of dividing them between the owner of the soil and the finder. It might be of interest to the meeting to know that one result of the Coroner's intervention in the Weybridge find, although it might not have been entirely legal, had been that a great portion of the coins were now in the British Museum. He thought the law might very well be extended to include at any rate all coins; and in the particular case he had mentioned, a very interesting find had been preserved for the benefit of numismatic science and for the nation.

Mr. MARTIN, in reply, said he was glad to hear it was the practice of the Treasury to return objects to the places where they were found when they were not required by the British Museum, and to divide the object between the finder and the owner of the soil. Granting such to be the case, he thought steps should be taken in every instance to bring this liberal action on the part of the Government to the knowledge of people who were likely to be finders. He did not agree with Mr. Rudler's suggestion that, supposing certain gold ornaments were found in Yorkshire, a proportion of them should revert to the locality of the find, because it was very rare that treasure trove was indigenous to the soil where it was discovered. He understood that the ornaments discovered in the north-west of Ireland were probably stolen from England, and that this country was the cradle of the

so-called Celtic art. That being so, what reason could there be for returning those ornaments to Ireland, unless to remedy another "injustice" to that country? He pointed out in his paper that if it appeared that the articles were actually made at the place where they were found, then he thought those to whom the custody of the treasure trove had been assigned might very well have jurisdiction to allow temporary exhibition of the relics at such a place, much in the same way that the South Kensington authorities allowed some of the contents of their art cases to be circulated round the country. He also thought it was an extremely good idea of Mr. Rudler's that the notices should appear in public houses, because that would be one of the best ways of bringing a knowledge of the Treasury's offer of reward to people who were likely to find relics in the soil. The Chairman had stated what the practice in regard to the dispersal of treasure trove by the Treasury authorities was, and in some cases it appeared to be extremely good. But the function of the Treasury was not to spend money unnecessarily, and if they could see their way to getting something for nothing on behalf of the public they would do so. It, therefore, seemed to him that the Treasury were not the proper people who should have the care and custody of treasure trove. It should go into the hands of people who were intimately interested in the subject, either some Government department or municipal authority, which should have the power to worry the Treasury for grants in aid, or for rewards to individuals in deserving cases. If that were the case, the local authority would very often insure the preservation of treasure trove which at present was either melted down for its bullion value, or was passed from hand to hand, so that its identification with a particular hoard or spot was lost. He was sorry to hear the Chairman's remarks with regard to the ownership of the contents of sepulchral barrows or graves, and would have liked to hear him say that, according to the law, they were treasure trove. The fact that he thought otherwise was a cogent reason, amongst others, why the law should be amended, so that the whole contents of a hoard, such as existed under mounds, could come together in one spot, be identified, and be preserved for the use of the nation at large. Before any amendment of the law could be made, antiquaries, lawyers, and all those interested in the preservation of old-time relics must agree as to the amendments they wished Parliament to make, and must show a united front. The Government, particularly in matters of art, did not lead but followed; and it was for those who were interested as members of the public in the preservation of relics of bygone times to importune the authorities into doing something to prevent the continuing loss of precious relics to the country.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Martin for his interesting paper, and the meeting terminated.

HOME INDUSTRIES.

The Manchester Canal.—The shareholders in this great national undertaking may be congratulated on having at length turned the corner. For the first time in its history the company has been able to pay the Manchester Corporation the full amount of interest accruing on its £5,000,000 loan, that is to say £160,000. At the annual general meeting, held last Friday, the chairman of the company indicated the possibility of the company being able this year to pay the Corporation an additional £10,000, as first dividend on its share capital. The full amount of the dividend payable on the $3\frac{1}{2}$ per cent. share stock allotted to the Corporation in satisfaction of the arrears of interest is £35,780, and any surplus beyond that amount would belong to the shareholders. The Ship Canal working profit for the year was £146,145, against £135,356 in 1906, being an increase of £10,789. The Bridgewater Department working profit was £15,556, compared with £15,299, an increase of £257 only. The working profit of the Ship Canal and the Bridgewater Department taken together amounted to £161,701. If the figures of 1904 are compared with those of 1907, it will be seen that during the last three years there has been a large increase in the traffic, amounting to 1,309,780 tons, of which 740,000 tons was coal, and the rest general merchandise. The imports of grain show large increases, 406,000 tons last year against 344,000 tons in 1906. The coal trade, too, has developed greatly. Some portion of last year's trade was due to the fact that the coast ports were blocked with traffic, and some of the traffic in Yorkshire coal was diverted to Partington, where the Canal's large exports take place. Whether the exports of coal this year will remain on such a large scale remains to be seen. The directors hope to strengthen their hold upon the American cotton trade, which they are anxious to see largely increased, but in order to increase it substantially a spot market in Manchester is necessary, and the directors of the Manchester Cotton Association are about to take an important step in the hope of increasing the stocks of cotton, and the business in ready cotton in Manchester. But it will require the co-operation of the importer and the spinner. The importing merchants will probably be willing to lay down larger stocks in Manchester to give the new experiment a fair trial, but everything will depend upon whether the spinners will support them. It is thought they will see that it is entirely to their interest there should be a strong rival spot market at Manchester. The company has to face less prosperous times, but the chairman is hopeful that they will not last long. There was a lean year in 1900, but in the following year activity was resumed and continued without a break down to the end of last year.

Fire Insurance Profits.—There is a general idea that the fire insurance companies make enormous profits. This opinion is encouraged by the large

figures with which the leading companies deal, and the tendency of some of them to treat claims in a somewhat illiberal spirit. But the actual figures do not support the contention that profits are excessive. A correspondent of a leading journal takes the results of the operations of between forty and fifty companies during a period of ten years. The profits in certain years appear to have been reduced almost to vanishing point, and certainly would not have provided an appreciable dividend on the capital invested. The average annual surplus for all the companies taken is £1,056,547, or rather less than half per cent. of the premiums received, and even after eliminating the year 1906, which is rendered quite exceptional by the conflagration at San Francisco, the average annual surplus on trading account during a period of nine years amounts to rather less than 8 per cent. of the total premiums received. But these figures do not accurately represent the position as between home insurers and the fire insurance companies. Practically all these companies draw from one-half to two-thirds of their business from foreign sources, which may well make a serious difference to the average result. Climatic and other conditions tend to make fires abroad larger and more frequent than in the United Kingdom, and in most of the large cities of the United States there are extensive areas so constructed and laid out that it requires only a spark to start a disastrous conflagration. It is a little surprising, perhaps, that the fire companies generally should have given so much attention to foreign business, at any rate American. The net profit over a series of years is hardly worth the energy and capital necessary to secure it.

Producing Plant.—One of the leading features of the trade activity of the last few years has been the extension of producing plant all over the world, and this has been particularly noticeable in the exports of British textile machinery, nor have the exports of the present year shown any sign of contraction. On the contrary there is continual expansion. The total declared value of these exports for last month was £773,611 as against £628,252 in January, 1907, and £532,593 in January, 1906. There is nothing necessarily strange in this when the point is considered, since of course the work of construction and completion may extend beyond the expansion of trade which gave the initial impulse to the increase of productive plant. Moreover, foreign countries who come to us for their producing plant are constantly extending their industrial competition. A noticeable increase in shipments of plant in the past month as compared with 1907 was in the case of Russia. In January, 1906, she took plant from us to the value of £28,094, in 1907 the value was £27,812, this year it was no less than £40,533. The American demand was not much more than half what it was last year—£36,389 as against £68,343. "Other countries in Europe" increased the value of their imports from £114,360 to £194,358, and Japan more than doubled hers, the value for January, 1907, being £23,021 as against £56,600 last month.

Hand Loom Weaving.—In Germany, as in this country, domestic hand loom weaving has been replaced to a large extent by the growth of the factory system, but there seems to be some possibility of a revival of cottage weaving in Germany through the invention of a new type of loom by a German weaver. The *Manchester Guardian*, which giving particulars of the invention, says that much interest is shown in the new loom in the district of Chemnitz. It is claimed for the loom that it combines a number of practical and valuable features. It is really an adaptation of the old hand loom to automatic action. It may be worked by a driving force equal to one-half horse-power which, it has been suggested, could be obtained from the municipal electric supply. A somewhat similar application of electric power to cottage looms has already been made in the French silk-weaving industry with considerable success. The German loom is built entirely of wood—like the old hand loom—the shafting and its accessories only being of iron. It can be set up in any room of ordinary size, the space required for it being 10½ feet in length, 7 feet in width, and 7½ feet in height. This is bigger than some of the newest Indian hand looms, but provision has been made in the space for the attachment of a Jacquard machine The loom is adapted for the use of a single weft thread only, but the inventor is hoping soon to apply a box arrangement, so that various threads might be employed. With suitable motive power, its production can, it is said, be made almost equal to that of ordinary power looms, whilst the small power required makes it very cheap to work, its cost complete being about £10.

The Fall in Coal.—It was foreseen that with slackening times in the iron, steel, and other important industries, a decline in coal prices was inevitable, but the actual fall in Welsh steam and bituminous coals has been much greater than the general anticipation. It has been greatest in best Admiralty steam descriptions. As compared with the top price, there has been a fall of 27·6 per cent., and if the price on January 1st is taken and compared with that of February 8th there is a fall of 2s. 3d. per ton. Making allowance for the fact that in August, when coal was at its zenith, values were to some extent inflated in consequence of the holiday shortages, there has been a fall of 5s. a ton since the summer, and of 2s. 3d. since January 1st. In other qualities the decline ranges from 1s. 3d. to 4s. 3d. per ton, and the corresponding percentages represent falls ranging from 7·3 to 20·7 since August, and from 6·6 to 11·8 since January. The falling off in the foreign demand, amounting to 12·5 per cent. in January, is a factor in the decrease. Over production and restriction in the business with middlemen and other contractors have also had much to do with the fall in prices, which would have been even more serious but that many of the collieries were engaged during the month working off arrears from last year.

OBITUARY.

ALFRED BALDWIN, M.P.—Mr. Baldwin, Chairman of the Great Western Railway Company, died suddenly of heart failure on the 13th inst., at his London residence, Kensington-palace-mansions. He was the youngest son of the late Mr. George Pearce Baldwin, iron founder of Stamport, and was born at that place June, 1841. In 1892 Mr. Baldwin entered the House of Commons as the Unionist member for the Bewdley division of Worcestershire, and he was re-elected in 1895, 1900, and 1906. At the time of his death he was Chairman of "Baldwin's" (Limited), iron and steel and galvanised and tin sheet manufacturers and colliery proprietors. Mr. Baldwin was elected a member of the Society in 1883.

GENERAL NOTES.

THE TRADE OF PORTUGUESE INDIA.—In Goa Portugal retains only a fragment of territory in India, and the lion's share of its trade falls to Britain. It is noticeable, in regard to the want of local enterprise, that the quantity of cocoa nuts exported is large, though far less than the possible production, while the amount of copra made locally is comparatively small, and the export of cocoa-nut oil next to nothing. The discovery of manganese has led to considerable enterprise in mining this ore. Mr. Consul Baker (Cd. 3727-38) says that only a few parcels of the ore as samples were exported up to the end of 1906, but during 1907 a considerable quantity was sent away. The concerns working the manganese mines are practically all British, developed by British capital. The total imports last year were valued at 49,56,785 rupees, and of these imports of the value of 46,47,476 rupees came from British India. The proportion of exports going to British India is even larger, 15,57,589 rupees of a total of 15,99,683 rupees. Even the coasting trade is mainly done in British bottoms. Of a total number of vessels engaged in it of 886, 646 were British, and of the total tonnage of 106,860 tons, 102,495 tons were British.

SUGAR CULTIVATION AND TRADE IN CUBA.—Some figures given by Mr. Vice-Consul Griffith in his report on the trade and commerce of Cuba, just issued (Cd. 3727-37), show what a small proportion of the area of the island is under sugar cultivation, although last year 1,427,673 tons were produced. The total area of Cuba is 28,160,000 acres. Of this, 15,451,264 are suitable for growing sugar-cane, but the actual area under sugar-cane cultivation is only 457,363 acres. A good deal of money is being spent in the construction of roads. The main feature in the plan of road construction is the uniting of various portions of existing roadways so as to form a highway traversing the island from Havana to Santiago de Cuba, with branches to the chief seaports and other points of importance. Of the total exports of merchandise, the United Kingdom and British possessions took about 7 per cent., as compared with $5\frac{3}{4}$ per cent. in the preceding year. Since the American occupation the population has increased, mainly through immigration, from 1,752,797 to 1,955,854, the death-rate of the island being 15·25 per 1,000 inhabitants. The Vice-Consul says there is great stagnation in business, and that a want of confidence is the prevailing feature in all branches of trade.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

FEBRUARY 26.—"The Problem of Road Construction, with a View to Present and Future Requirements." By PROF. H. S. HELE-SHAW, LL.D., F.R.S., and DOUGLAS MACKENZIE. The HON. RICHARD CLERE PARSONS will preside.

MARCH 4. — "Modern Dairy Practice." By LOUDON M. DOUGLAS.

MARCH 11.—"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By ERNEST R. MATTHEWS, F.R.S.E.

MARCH 18.—"Impressionist Painting: its Genesis and Development." By WYNFORD DEWHURST. The EARL OF PLYMOUTH, C.B., will preside.

MARCH 25.—"Recent Improvements in Decorators' Materials." By A. S. JENNINGS.

APRIL 1.—"The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE.

APRIL 8.—"Technical Education in America." By SIR WILLIAM H. PREECE, K.C.B., F.R.S.

APRIL 29.—"Modern Roumania." By ALFRED STEAD, Consul-General for Roumania." SIR PERCY SANDERSON, K.C.M.G., will preside.

Dates to be hereafter announced :—

"The Underground Water Supplies of the Thames Basin." By CLAYTON BEADLE.

"Industrial Entomology: the Economic Importance of a Study of Insect Life." By F. MARTIN DUNCAN.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MARCH 12.—"Progress of Native States during the past Forty Years." By SIR DAVID W. K. BARR, K.C.S.I., Member of the Council of India. The RIGHT HON. LORD CURZON OF KEDLESTON, G.C.S.I., G.C.I.E., will preside.

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock :—

FEBRUARY 25. — "Irrigation in Egypt under British Direction." By SIR HANBURY BROWN, K.C.M.G. The EARL OF CROMER, O.M., G.C.B., G.C.M.G., K.C.S.I., will preside.

MARCH 24.—"The Mineral Resources of Western Australia." By the HON. C. H. RASON, Agent-General for Western Australia.

APRIL 7.—"The Imperial Problem of Asiatic Immigration." By RICHARD JEBB.

APPLIED ART SECTION.

Tuesday evening, at 8 o'clock :—

MARCH 31.—"Enamel Portraits." By CYRIL DAVENPORT, F.S.A. SIR HUBERT VON HERKOMER, C.V.O., R.A., will preside.

APRIL 28.—"Lace as a Modern Industry." By Miss ISEMONGER.

MAY 26.—

CANTOR LECTURES.

Monday evening, February 24, at 8 o'clock :—

HENRY HARDINGE CUNYNGHAME, C.B., "The Theory and Practice of Clock Making." Six Lectures.

LECTURE VI.—FEBRUARY 24.—The theory of escapements concluded—Teeth of wheels—The theory of epicycloidal teeth — Involute teeth — Lantern pinions—Electric clocks—Main divisions of electric clocks—Difficulties to be contended with—The clock of the future.

PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." Four Lectures.

March 9, 16, 23, 30.

WILLIAM BURTON, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.

May 4, 11, 18.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

Friday evening at 8 o'clock :—

FEBRUARY 28.—"The Removal of Dust and Fumes in Factories." By Dr. JOHN SCOTT HALDANE.

MARCH 17 (Tuesday).—"Child Workers and Wage Earners." By MISS NETTIE ADLER, Hon. Secretary to the Committee on Wage Earning Children.

MAY 15.—"The Dangers of Coal Dust and their Prevention." By W. E. GARFORTH, President of the Colliery Proprietors' Association of Great Britain.

HOWARD LECTURES.

Thursday evenings, at 8 o'clock :—

H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

March 19, 26, April 2.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Henry Hardinge Cunynghame, "The Theory and Practice of Clock Making." (Lecture VI.)

Farmers' Club, Whitehall-rooms, Whitehall-place. S.W., 4 p.m. Mr. C. Middleton, "Present and Future Aspects of Dairy Regulations."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. G. S. Rolleston, "The Small Holdings and Allotments Act, 1907."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

Actuaries, Staples-inn-hall, Holborn, W.C., 5 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, FEB. 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) Sir Hanbury Brown, K.C.M.G., "Irrigation in Egypt under British Direction."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Stirling, "Membranes: their Structure, Uses, and Products." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. William Barclay Parsons, "The New York Rapid-Transit Subway."

Faraday Society, 92, Victoria-street, S.W., 8 p.m. 1. Dr. V. H. Veley, "Hydrolysis as Illustrated by Heats of Neutralisation." 2. Dr. Joseph Knox, "A Study of the Sulphur Anion and of Complex Sulphur Anions."

Anthropological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, FEB. 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. H. S. Hele-Shaw and Mr. Douglas Mackenzie, "The Problem of Road Construction with a view to Present and Future Requirements."

Islamic Society, Caxton-hall, Westminster, S.W., 8¼ p.m. Prof. Shaikh Mohd Iqbal, "Mysticism in Islam."

United Service Institution, Whitehall, S.W., 3 p.m. Brigadier-General H. H. Wilson, "Staff Rides."

Royal Society of Literature, 20, Hanover-square, W., 8½ p.m.

Optical Society, 20, Hanover-square, W., 8 p.m. Annual meeting.

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

THURSDAY, FEB. 27...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Junior Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Mr. E. A. Rickards, "The Architecture of Monuments."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Somerville, "Wood: its Botanical and Technical Aspects." (Lecture II.)

FRIDAY, FEB. 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Shaw Lecture on Industrial Hygiene.) Mr. John Scott Haldane, "The Removal of Dust and Fumes in Factories."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. A. Bone, "Explosive Combustion, with special References to that of Hydro-Carbons."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Physical, Royal College of Science, South Kensington, S.W., 5 p.m. 1. Mr. S. W. J. Smith and Mr. H. Moss, "Contact Potential Differences Determined by Means of Null Solutions." 2. Mr. Lewis, "An Experimental Examination of Gibbs' Theory of Surface Tension as the Basis of Absorption with an Application to the Theory of Dyeing."

SATURDAY, FEB. 29...Royal Institution, Albemarle-street, W., 3 p.m. Mr. Selwyn Brinton, "The Art of Florence." (Lecture III.)

Journal of the Royal Society of Arts

No. 2,884. VOL. LVI.

FRIDAY, FEBRUARY 28, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 4, 8 p.m. (Ordinary Meeting.) LOUDON M. DOUGLAS, "Modern Dairy Produce."

Further details of the Society's meetings will be found at the end of this number.

FOTHERGILL PRIZE FOR LIFE-SAVING APPARATUS.

The Council of the Society of Arts are prepared to award, under the Fothergill Trust, a Gold Medal, or a prize of £20, for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious.

It is intended that the apparatus sent in shall be submitted to practical trials and tests.

In the award of the Medal regard will be had, firstly, to excellence of design and contrivance, and, secondly, to excellence of manufacture. Credit will be given to such parts of the apparatus as are the invention of the exhibitor; the object being to distinguish the apparatus which gives the best promise of being practically useful.

Inventors intending to compete should send in a notice of their intention, together with a full description of their inventions, *not later than 31st March*, 1908, to the Secretary of the Society of Arts, John-street, Adelphi, London, W.C., and in cases in which the apparatus has been put into actual use, the experience of such use should be given, and the special points of merit of the apparatus indicated.

Notice of the place to which the apparatus is to be sent will be subsequently sent to those competitors whose apparatus the judges may desire to test, together with an indication of the tests, and of the manner in which they will be conducted.

Competitors intending to patent their inventions should be careful to obtain protection, as the Council of the Society cannot undertake any responsibility as regards the secrecy of the whole, or of any part, of an invention submitted to them.

The Prize will be awarded on the report of judges appointed by the Council.

The cŏmpetition is not limited to British subjects.

The Council reserve to themselves the right of withholding the Prize, of extending the time for sending in, or of awarding a smaller Prize or smaller Prizes.

CANTOR LECTURES.

On Monday evening, 24th instant, Mr. HENRY HARDINGE CUNYNGHAME, C.B., delivered the sixth and last lecture of his course on "The Theory and Practice of Clock Making."

A vote of thanks to the lecturer for his valuable course was passed unanimously on the motion of the CHAIRMAN (Charles Vernon Boys, F.R.S.).

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, February 25; The RIGHT HON. THE EARL OF CROMER, O.M., G.C.B., G.C.M.G., in the chair. The paper read was "Irrigation in Egypt under British Direction," by SIR HANBURY BROWN, K.C.M.G.

The paper and discussion will be published in a future number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday Afternoon, February 13th; The RIGHT HON. SIR ALFRED C. LYALL, G.C.I.E., K.C.B., in the chair.

The CHAIRMAN stated that the author of the paper had been recalled to India, where he was working against famine in the United Provinces, but in his absence Mr. William Foster had kindly consented to read the paper.

The paper read was—

THE IMPERIAL GAZETTEER OF INDIA.

By RICHARD BURN, I.C.S.

It is perhaps superfluous, in a paper read before the Royal Society of Arts, to dwell at any length on the ignorance regarding India which prevails among the people of this country, for the energies of the Society are directed towards placing before the public summaries of recent advances in various branches of knowledge, and the importance of India is recognised by the fact that matters relating to it are dealt with in a special section. To the Anglo-Indian official, however, the question is ever present. So long as the ultimate control over the administration of India is vested in the Parliament of this country, it will always be desirable that, both for the representatives of the people and for the people themselves, information on India shall be available in an accessible and authoritative form. "Pagett, M.P.," has acquired aplace in the portrait gallery of British types, and his successors are the cause of amusement, alternating with despair, among those who spend their lives in the East. There have been notable examples, in recent years, of ignorance and oversight of India displayed by politicians of high rank, which need not be mentioned in detail. When the local magnate undertakes a tour round the world, he usually contributes a series of letters, descriptive of his wanderings, to the local papers. Most of us have read such letters, and smiled over them. No doubt the magnate is a high authority in his own circle; but when he turns aside from a plain description of what he has seen to explain the history of a city, or to describe the various peoples of India, their languages and religions, ludicrous mistakes come from his pen. Kings of Oudh rule at Delhi; Mohammedans are converted, by some strange process, into Hindus; while the philology is of the high order which derived Latin from Greek. There is a story of an officer belonging to the British army in South Africa, who was constantly stumbling over difficulties in his dealings with native drivers. One of these died, and the officer was much perplexed about the disposal of the body, having some vague recollection that Indians had peculiar notions on the subject. So he telegraphed to a friend belonging to the Indian army, who was stationed some distance away: "Another Bux dead. Shall we burn or bury?" Perhaps no topic connected with India presents more difficulty than that of caste, but a British officer of high position recently proposed a solution which is almost convincing from its simplicity. "Caste," he said, "does not exist, but is a gigantic swindle, to impose on the European."

It can hardly be said that this ignorance, although so conspicuous, is due to the absence of materials from which information could be gleaned. Nearly eighty years ago the Government of India was described as a "*naksha raj*," or government by statistics, and its output has been immensely increased since that date. So great, in fact, had it become, that Lord Curzon's Government was impelled to apply the drastic remedy of limiting the number of pages and statistical tables in each report, and it will no doubt be part of the duties of the Royal Commission on Decentralisation, now working in India, to enquire whether further reductions are feasible. Where the material is so extensive, a guide is required by all who are not experts in the various subjects dealt with in the reports on different branches of the administration. It is with some surprise that English students of ethnography learn that Indian census reports contain the results of the latest researches into the religious and caste system of the country; and although many unexpected subjects are in fact dealt with in official reports, there are others which do not find a place.

When the East India Company began to undertake the administration of parts of India, in addition to its earlier functions of trading, the necessity for detailed information about the people and country under its control became evident, and steps were taken to gather it. The results, no doubt, served to some extent the purpose of local officials in India,

but the vast piles of manuscript which still survive the attacks of insects and climate in that country, and the lesser, but by no means insignificant, stores in the India Office are rarely disturbed, in spite of the value of their contents. The development of new methods of historical research which have left such a mark on the literature of most countries in Europe has hardly affected India at all. Historians are still wrangling over the dry bones of political occurrences, and more attention is paid to the articulation of a skeleton than to the reconstruction of its form when clothed with flesh. It is true that during the first half of the nineteenth century a number of excellent memoirs on individual districts were compiled by District Officers. But the accounts were uneven, and more complete organisation was required before it could be said that even a moderately complete account of British possessions in India had been prepared. When the country was settling down after the convulsion of 1857, and its financial position was more assured, the opportunity arrived; and it was fortunate that the Indian Civil Service included in its ranks a young member whose ability and energy were devoted throughout his life to the task of interpreting to its rulers India and all it contained. About forty years ago Mr. (afterwards Sir) W. W. Hunter developed a scheme which resulted in the preparation of more adequate accounts than then existed of practically the whole of British India and some of the Native States. While bearing different names, and varying in scale and arrangement, the imposing array of volumes published between 1870 and 1890 affords a description of the country in greater detail than exists for many European countries, and forms a fitting memorial of the skill of its designer and of those who actually carried out the work. In the discussions which took place about the form of the new edition of the "Imperial Gazetteer," a high tribute was paid by Lord Curzon to the practical value of the old Statistical Accounts, District Manuals, or Provincial Gazetteers, as they were variously called. They have long been the subject of continual reference by successive District Officers, while higher officials frequently found them of the greatest use, in spite of their being to some extent obsolete.

In a country like India, where the mass of the population cannot read and write even their own vernaculars, to say nothing of English, reports and gazetteers of the kind under discussion are primarily intended for official use. At the present time works relating to Indian Districts on the scale of the Victoria County Histories in England are almost unthinkable. If by some lucky chance it were possible to concentrate the labours of students and deal with a single area, as most Districts in India could be dealt with, the result would be so costly a volume that Government could hardly undertake it, and no publisher would look at it. No one realised more completely than Sir William Hunter the ignorance of Indian conditions which prevails in this country, and no one has done more to dispel it. The first edition of the "Imperial Gazetteer" was designed by him for the use of the British public, as he recognised that the series of volumes forming the Statistical Survey, already alluded to, was practically within the reach of but a small official class. He himself described the "Imperial Gazetteer" as "a foundation for a truer and wider knowledge of India in time to come. Its aim has been, not literary graces, nor scientific discovery, nor antiquarian research, but an earnest endeavour to render India better governed, because better understood."

The success of the first edition within a few years led to the production of a second edition, which appeared in 1885-7. Revision and expansion had caused the work to grow from nine volumes to fourteen. Books of this nature are necessarily ephemeral, owing to the large amount of statistical matter which they must contain; and, although for a considerable period it is possible to make use of an Indian gazetteer, supplemented by such publications as the annual statistical tables issued by the Government of India, the decennial reports on the census and on material and moral progress, the desirability of completely revising a work intended for those to whom such records are not readily accessible is obvious.

It has been said already that the "Imperial Gazetteer" was originally intended for the use of readers who had no intimate knowledge of India; and the statement will bear repetition, because Sir William Hunter has been unfairly blamed for omitting to carry out what he never undertook—the preparation of a work which would serve the use of officials as well as those who required only a modicum of information. Setting aside criticism of that nature, it is still possible to point out defects in the work. While the new edition, which will presently be described, was being planned, the articles in Sir William Hunter's second edition came under the close scrutiny of experts. They were

criticised for their arrangement; some were seen to be redundant, while others were very deficient. The selection of subjects for articles was particularly open to criticism. In several cases articles appeared to have been written on the same places with different titles, while in other cases there had been confusion between places of the same or similar names. The important group of Native States, known collectively as Central India, is dealt with in less than twenty pages, including articles on individual states and places in them. It is easy to explain these defects, and in most cases to excuse them also. The scope of the work was so wide that one man could not possibly write the whole of it, if it were to be published in reasonable time. Sir William Hunter, therefore, had the assistance of a number of writers in England, but it is unfortunately the case that some of these were chosen for their literary qualifications rather than for their knowledge of India. Moreover, the insufficiency of some of the articles was due to the fact that materials were not readily available. Few writers have been more skilful than Sir William Hunter in making the most of scanty and unpromising material, but there were unfortunate blanks in the information supplied and they remained unfilled. Lastly, it must be admitted that, great as were his capabilities as a writer, Sir William Hunter's work was marred by his neglect of the scrupulous accuracy which is demanded by the modern school of historical writers, and in particular by his failure to verify references. I have seen it asserted, though possibly in jest, that he described certain temples as situated on top of a hill, while in fact they were half-way down, because it appeared to him that they would present a more picturesque appearance on the top of the hill.

The suggestion that a new edition of the "Imperial Gazetteer" should be prepared came in 1899 from Sir William Hunter himself. He pointed out that the first census to be taken in the present century would be a fitting opportunity. Although the suggestion was at once accepted in principle, it was not till the following year that the discussion of details began, and by that time Sir William Hunter's death had taken place. His great experience was thus no longer available; but it is noteworthy that almost all the Indian officials who had to deal with the drafting of the scheme, Sir John Hewett, Sir Herbert Risley, and Sir Denzil Ibbetson, had had practical experience of Gazetteer work, and in some cases had been directly connected with the earlier Statistical Accounts prepared under the general guidance of Sir William Hunter. The services rendered by Mr. J. S. Cotton to the earlier editions of the work were specially acknowledged by the editor, and it was thus peculiarly fitting that he should be nominated by the Secretary of State to supervise in England the preparation of the new edition.

It is not my intention to weary you by detailing the numerous proposals and counter-proposals which followed the decision that a new revised gazetteer should be prepared. There is a story relating that a newcomer in the secretariat of the Government of India was appalled by the number of officials whom it was deemed necessary to consult regarding a certain file. In sending it on, he noted (whether ingenuously or with undue levity must not be enquired) that by some mistake the file had not yet been submitted for the opinion of the Bishop of Calcutta, though all other high officials had seen it. So thorough was the examination of the "Gazetteer" file that, although steps were taken to begin the collection of material as early as 1900, it was not till nearly three years later that the form in which the work should appear was finally decided. To sum up briefly the objects which have been prominently held in view, it may be said that while the last edition, being designed specially for the British public, was not required to be in any way exhaustive, the new work is also intended to be of use to officials in India. Moreover, while the compilers twenty years ago were under the necessity of simply making the best of what they found ready to hand, it was now decided to lay down a syllabus for each class of article and to make special efforts to gather the information required by the syllabus.

One addition made deserves immediate notice. The second edition of the "Gazetteer" contained a single map showing the whole of India on a very small scale. The new edition includes an Atlas of India, consisting of 64 maps and plans, while a map of India on a much larger scale than the old one has been bound in each volume. Mr. W. S. Meyer, as Indian editor, drafted the scheme on which the atlas has been prepared. Various maps show the physical features of the country, its climate and products, whether vegetable or mineral. Others have been devised to exhibit the net-work of railways and telegraph wires which have done so much for the development of the country in the last

fifty years. For the use of the historian and archæologist, plans have been made showing the principal sites of archæological interest, and the extension of British rule. For each Province or large Native State or group of States, a separate map or series of maps has been prepared on a uniform scale, while separate plans have been added for a number of the most important cities, selected for their prominence from an historical, administrative, or commercial point of view. No part of the "Gazetteer" has received more careful attention than the Atlas. The scheme of names to be included was minutely scrutinised in India and in England to secure the inclusion of really important places, and at the same time to prevent the overcrowding which is so annoying to the student.

The "Gazetteer" may be roughly divided into two parts, one dealing with India as a whole, and the other describing the various Provinces and States, with their sub-divisions and places or other geographical units contained in them. In the old edition, India formed the subject of a single volume, which was subsequently republished separately, and passed through several editions, being revised and enlarged, under the title of "The Indian Empire." This volume was written entirely by Sir William Hunter, and is perhaps the best known of his works. As a pioneer production, composed by a single writer, it well deserves the reputation it has achieved; but when judged by the standards laid down when the new edition was decided on, its defects were obvious. Sir William Hunter himself once described it as written in his spare time, and an accurate estimate of his qualities and their limitations can be obtained by perusing it. Picturesque diction and clearness of expression adorn all parts of the book, but it is unfortunately marred by want of proportion and the inaccuracy which is so fatal to the value of books of this nature. In considering the revision of this part of the "Gazetteer" especial care was taken to guard against the defects noted already. To judge by the press notices of the three volumes which have already appeared, a considerable measure of success has been achieved. In place of a single volume, four volumes have been allotted to the account of the Indian Empire. They deal respectively with the description, history, economics, and administration. Each volume was blocked out into chapters, and the preparation of each chapter was entrusted to an expert, selected for his special knowledge of the subject to be handled. Nearly forty writers have been engaged on the production of this portion of the "Gazetteer." In most cases, the scheme of the chapter was discussed by the author and editor before it was begun, and there were instances where whole chapters were re-written or re-arranged before being finally approved. The English editor was primarily responsible for the volume dealing with history, and for a number of chapters in the descriptive volume, and the Indian editor for the remainder, but in either case the chapters were read by both and freely commented on. It may also be mentioned that chapters prepared in India were scrutinised by the various departments of the Government of India controlling the branches of the administration described in them.

The articles in the rest of the "Gazetteer" fall naturally into groups according to the Provinces or States which they describe, and about twenty-five contributors have written the greater part of these. For the larger Provinces and States Superintendents were appointed on special duty, and in the case of most places local knowledge was ensured by the selection of officers who had been recently engaged in taking the census of 1901. In other cases it was found possible to secure the services of contributors qualified by long residence or special study to prepare accurate and complete accounts. Each of these Superintendents and compilers has made copious use of the special knowledge possessed by various official and non-official experts within the area dealt with by him. Paragraphs on technical subjects, such as geology, botany, meteorology, and forests, have been supplied by the scientific departments under the Government of India.

The articles making up the bulk of the "Gazetteer" may now be described in more detail. In the first place comes the articles on Provinces and groups of States, such as Rajputana and Central India. Such articles were planned as carefully as the chapters in the four volumes of "The Indian Empire." A detailed syllabus was laid down for each section, and a series of statistical tables was drawn up to illustrate the condition of the Province since 1880. As a rule the description of one of the larger Provinces will occupy from 100 to 150 pages. Separate articles have been compiled on important tribes occupying a specific area, such as the Bhils; on mountain ranges; on lakes, islands, rivers and canals; and on the more important areas bearing an historic name, such as the Deccan. The

greater part of the "Gazetteer" is, however, taken up with the description of the administrative units known as Divisions, Districts, and Tahsils, or corresponding areas, together with articles on large estates and towns or other places. Roughly speaking, about half the space allotted to a Superintendent was to be taken up by the description of Districts, the most important administrative units in India, which are comparable to counties in England as nearly as any comparison is possible. Reference has already been made to the criticism of the selection of subjects for articles in the old "Gazetteer." Where space is valuable it is hardly worth while to have an article on a place with a population of about 1,500, about which nothing more can be said than the fact that "it is pleasantly situated among groves of mango trees." Particular attention was devoted to this matter before work began. It was laid down as a guide that separate articles should be prepared on all municipalities, cantonments, district headquarters stations, towns with a population of not less than 5,000, places of historical, religious, or archæological interest, and places of some local importance from an industrial, commercial, or railway point of view. Articles also appear on the French and Portuguese possessions in India, which owe much to the courtesy of the officials of the two countries. It has already been stated that India, as a whole, is described in four volumes. The articles just referred to on Provinces, &c., will be comprised in twenty volumes; so that, adding the Atlas and an index volume, the whole work consists of 26 volumes, compared with 14 in the old edition. It will be found that the increase in bulk is fully justified by the necessity for describing the new territory acquired during the last 25 years in Upper Burma and Baluchistan, as well as by the more complete description of areas and places previously dealt with imperfectly or altogether omitted. The care with which selection has been made is well illustrated by the statement that, while the new edition contains more than 6,100 separate articles, nearly 1,900 are on titles not dealt with in the old edition; but, on the other hand, as many as 3,400 contained in the latter have been discarded.

Before describing the steps taken to compile articles a word is necessary on the form of the "Gazetteer." Hitherto, in both editions, the arrangement has been purely alphabetical. In the new edition, the volumes dealing with India as a whole are placed at the beginning, forming Vols. I. to IV. In the next twenty volumes articles are arranged alphabetically in what is called the "Imperial Gazetteer;" but, at the request of the Government of India, the Secretary of State has sanctioned another edition, which will be called the "Provincial and State Gazetteer" series, as distinguished from the "District and State Gazetteers" which represent the old statistical survey. This new Provincial series, which is practically ready, contains the whole of the articles included in the alphabetical volumes of the "Imperial Gazetteer," but they are collected by Provinces or States and published in a separate volume or two volumes for each Province, State, or group of States. Moreover, the arrangement within each "Provincial Gazetteer" is geographical, not alphabetical. First comes an article on the Province, followed by articles on such subjects as mountains, rivers, canals and the like. These are followed by an article on a Division, attached to which are articles on the Districts it includes and places situated in those districts. Although the "Imperial Gazetteer" was originally not designed for the use of officials in India, the need in that country for something more convenient than the bulky "District Gazetteers" has long been felt, more especially by the increasing number of officials who have to tour over a whole Province or over the whole of India. It is confidently anticipated that the "Provincial Gazetteers" will be found of great use by such officials.

While touring in Southern India, as editor of the "Gazetteer," I visited the goldfields of Kolar, and was struck by the analogy between the work to be seen there and the method in which the "Gazetteer" was being prepared. Far down in the recesses of a mine rough fragments of ore were being laboriously extracted by half-clad labourers. The ore was collected and brought to the shaft, raised to the surface, carefully picked over and then passed to the mill, where powerful stamps reduced it to powder. After a variety of processes, each carefully supervised, the furnaces were reached, from which emerged small ingots representing a very minute fraction of the tons of ore from which they had been extracted. Lastly, the ingots were despatched to England, where they were subjected to a final treatment before being placed on the market as pure gold. It has been remarked that the whole fabric of Indian administration depends ultimately on the *patwari*, or village accountant, and the *chaukidar*, or village

watchman; and it is certainly true that three great branches of Indian statistics depend largely on these humble officials; for statistics of cultivation are collected by the *patwari*, and vital statistics by the *chaukidar*, while both take part in the census operations on which statistics of population are based. Subject to the condition that they produced articles in conformity with the scheme laid down, the "Gazetteer" Superintendents had practically a free discretion to collect material in the manner best suited to their Provinces. In some cases the opportunity was taken to revise, *pari passu*, the old "District Gazetteers," and the same material was available for both these and the "Imperial Gazetteer." This was the case in the United Provinces, the Central Provinces, Bengal, and Assam, where the old "District Gazetteers" are being completely revised, and also in Baluchistan, where these are being produced for the first time. In Madras and the Punjab a few "District Gazetteers" are being revised. Some Superintendents supplied District Officers with specimen articles and asked them to draft similar articles for their own districts and places in them. It is noteworthy that very little use was made of the old edition, excepting a few descriptive passages and some of the historical paragraphs which could be readily verified. In one Province the first drafts were based on Hunter to a larger extent, but they required far more revision than articles prepared in other methods. Whatever the manner in which the drafts were compiled may have been, they came at some stage under the careful examination of the District Officer and if possible a Settlement Officer. I am glad to have this opportunity of recognising gratefully the part taken by District Officers in the collection of material and in the checking of drafts. More than half the work rests ultimately on their authority, and those who know India and its administration will support the assertion that it could have no surer foundation.

Though the actual text of the previous edition was thus discarded to a very large extent, it was valuable as a guide to matters to be noted; and the work presenting most difficulty was that connected with newly acquired territory, such as Upper Burma and Baluchistan, or with areas previously treated inadequately, such as Central India. In Baluchistan much of the information is absolutely new. Mr. Hughes-Buller's first task was to train men in the matters to be noted, and then send them out as explorers. In most Native States the administrative machine is less fully organised than in British India; and although the chiefs, without exception, have shown the keenest desire to co-operate, statistics were sometimes lacking, and other information was difficult to obtain. Some of the smaller States in Central India, for example, supplied notes written in the local dialects and local characters which could not be read by the clerks at headquarters, so that men had to be called for to interpret them. The amount of personal interest taken by some chiefs was in itself a source of embarrassment at times, as it took the form of a desire to eliminate episodes in the history of their States, or else caused delay by their determination to check the whole description themselves.

When the articles for a Province or State had been completed, they were submitted to the Local Government or Political Officer for a final examination; so that the work has received an official imprimatur which was lacking in earlier editions. So many articles were read and criticised by higher authorities that I remember seeing a note of Lord Curzon's, in which he protested that he really could not find time to act as a sub-editor of the "Gazetteer" in addition to his duties as Viceroy. To facilitate the examination of articles in India, almost the whole "Gazetteer" was actually printed there in draft, and this has added appreciably to the labours of Superintendents. A hundred years ago, the translator of the Sair-ul-Mutaakhirin complained about his Indian printer: "The word V-e-z-i-r has been in some places V-i-z-i-e-r, &c., nor have my endeavours been able to wean the printer from that practice and some others. But printers have been guilty of an infinity of alterations, both through chance and through wilfulness." Such troubles are still to be experienced in India, where compositors in some presses know no English except the alphabet. It is needless to remark that the final printing in England, being done at the Clarendon Press, has been free from such harassment. Another difficulty has been caused by administrative changes made while the "Gazetteer" was being compiled. The creation of two new departments of the Government of India, the re-organisation of the army, the division of Bengal, and a number of minor changes, have had to be noted. Wherever possible the new state of things has been described, but sometimes it has been necessary to allow articles to

stand as written, while calling attention to the changes made, and giving as full details as could be recorded of the present conditions. When articles had been completely examined and edited in India, printed copies were sent to the English editor, who subjected them to a further examination, and discussed his corrections with the Indian editor before they were finally incorporated. In this way the work has received the benefit of Mr. Cotton's life-long study of India as well as of his literary attainments, which are familiar to you all. It may, perhaps, be mentioned here that the post of Indian editor has been held in turn by three officials. In the first place, Mr. (now Sir Herbert) Risley was appointed editor while holding the post of Census Commissioner. To him fell the task of preliminary organisation, and the sketching of the broad outlines of the work. But, although his connection with the "Gazetteer" as editor ceased before articles were ready for his approval, he has continued to be closely concerned with it in his capacity as Secretary to the Government of India in the Home Department, which deals with the matter. He was succeeded by Mr. W. S. Meyer, who worked out the details of the scheme, including the Atlas, and edited almost all of those parts of "The Indian Empire," which were prepared in India. Mr. Meyer also supervised closely the progress of the work done by Provincial Superintendents, and most of the articles on Provinces as a whole had received the benefit of his criticism in their first forms. The final editing of the bulk of the twenty volumes, alphabetically arranged, was the task remaining for me when I took charge in February, 1905.

There have been times when both Mr. Cotton and the Indian editor have been tempted to apply to themselves the definition which Dr. Johnson gave of the term "lexicographer," namely, "a harmless drudge." But an occasional specimen of unconscious humour has helped to lighten our tasks. For example, we have been informed that "the wants of a certain Province were made locally." Of one place it was written that "its ruins cover about fifteen square miles, and consist of a forest of mango trees, with numerous tanks and temples scattered among them." A district is said to be "an extensive rolling plain, consisting of alternate ridges of bare stony hills and narrow fertile valleys." We have been asked to see evidence of cash hoarding in the increase of currency notes in circulation and in the rise in savings bank deposits; while we were assured that the standard of comfort was rising because of the increasing use of cheap European luxuries such as American drugs. An interesting item of natural history is afforded by the remark that "the buffalo differs from the cow in giving a milk which is richer in butter fat, in voice, and in having no hump."

The first Indian "Gazetteer," known as the Ain-i-Akbari, was completed rather more than 300 years ago, and I cannot conclude more fitly than by fully endorsing the final words of its author, Abul Fazl:—

"Praise be unto God that the Institutes of Imperial Administration have been completed, and a general survey of the Empire, by the aid of Divine grace, placed upon record. The numbers of the tribal contingents and the chronology of the ancient kings, with some other particulars, have cost considerable labour; and from the conflicting accounts received, I was well nigh relinquishing the task, but the decrees of fate cannot be resisted. I have set down what has best commended itself to my judgment, hoping that it may win lustre from the light of public acceptance, and its errors escape the carping of illiberal criticism."

DISCUSSION.

The CHAIRMAN (Sir Alfred Lyall), in opening the discussion, said the most interesting and instructive paper which had been read contained the statement that the end of a great enterprise, the germ of which might be traced back at least forty years, had arrived. When one heard of the care, skill, experience, and literary power which had been employed upon the work, the great staff which had been assembled to compile it, the constant reference to the best authorities and the general scope and style of the writers; and when one also remembered what the germ was forty years ago, he was struck with the growth of such a great enterprise. In his opinion, the author did not go back quite far enough in beginning with Sir, or as he then was, Mr. William Hunter. A great deal was due to Sir William Hunter in the matter, in spite of the errors that had been referred to, and his occasional want of accurate knowledge. The truth was, however, that the work was begun some time before Sir William Hunter took it up, and he thought it was worth while that the first pioneer should be referred to. He believed the first Gazetteer was suggested and sanctioned by the Central Provinces about 1865 or 1866, the first person who suggested the idea being Mr. Rivett-Carnac, the Settlement Officer. It was taken up, organised, and generally encouraged in every way by the late Sir Richard Temple, man who was open to every idea, and who was always glad to take up a new adventure. The work seemed

to contain an inexhaustible source of almost every kind of information, and there could be no doubt of its use in England any more than in India. He had sometimes thought that, like some other works, the business of compiling it was almost as valuable as the business of reading it would be. It was just possible that the district officers and other officials in India when they had the "Gazetteer" in their libraries, and could look up at any moment any particular fact or statistic, might not take so much trouble as older officials had to do in looking up information for themselves. Encyclopedias, Gazetteers, and Dictionaries of National Biography sometimes produced a certain atrophy of personal research, but he supposed it was impossible to have anything without some small disadvantage. The author was rather hard on the historians of India when he said that "the development of new methods of historical research which have left such a mark on the literature of most countries has hardly affected India at all. Historians are still wrangling over the dry bones of political occurrences." Personally he should have thought that research had gone a long way of late in India. Epigraphy had made great strides; monuments had been carefully investigated; and the method of correcting and enlarging the whole idea of history had had considerable effect upon the later historians of India. All the old histories were very valuable indeed and must not be hastily set aside. For instance, Grant Duff and other people who wrote the old works upon Mysore did most valuable work which was still of great use in these days. It must not be supposed that the "Gazetteer" in any way superseded history, and, after all, political events in India, although they might be called dry bones, were very important things. Anything like a full account of the castes of India was of immense value. He remembered the time when the Census Reports of India had no reference whatever to caste, or religion, those returns not being made until 1870. Details were now given, and many other particulars with regard to the manners and customs of the population. But visitors to India had to remember that such things were constantly changing, and the "Gazetteer" to be useful would require constant revision, which was one of the penalties which comprehensive accuracy in such a vast work suffered. The "Gazetteer of India" was a great work, which had been produced by laborious, industrious, and civilised people, who could speak upon every department, and it would remain, at any rate, a great Imperial monument. He thought those who had built it up were to be complimented and thanked for it. He was glad to see that the author ended with a reference to Abul Fazl, who 300 or more years ago put into very real outline something of what the new "Gazetteer" had tried to do in magnificent detail. Abul Fazl's account might seem curious and odd, but it attempted to describe the twelve parts of the Empire, and his shadow fell over the present work.

Sir Richard Temple, Bart., C.I.E., thanked the Chairman for his kindly reference to his (the speaker's) father, whom he was pleased to hear, for the first time, was a pioneer in Gazetteer work. He believed that Dr. George Balfour, the eminent surgeon of Madras, compiled a Gazetteer of India about the year 1863, which was earlier than any other book yet mentioned. Sir Richard Temple also desired to express his thanks to the author for dispelling a great number of errors as to the methods by which the Gazetteer had been built up. He was sorry to say, from the point of view of personal vanity, that his own work for the Gazetteer had wholly missed notice in the general account of it: but he was not surprised because it fell to his lot to describe the conditions and surroundings under which convicts and savages lived, a subject which was not likely to come under the purview of the general public. It had been stated in the paper that a vast amount of ignorance existed in England with regard to the people of India generally. Great as that might be, he thought the ignorance of the world on the subject of savages was greater still. It was a mistake to overlook savages in human studies, because the more a savage was studied the more it would be found that he was a true human being, and that the motives which moved him and the arguments which guided his actions vere very much those that guided civilised beings. A savage was really the prototype of civilisation, and, therefore, it would always be well to learn as much as possible about him. The savages he (the speaker) had to deal with, lived in the Andaman and Nicobar Islands, but even a careful study of people living in such out-of-the-way places could be of practical value to individuals who studied India generally. For instance, the Chairman had alluded to the great difficulty of learning about caste. The birth of a caste, and its first rise was one of the most obscure subjects imaginable. It was, therefore, a great pleasure to him to be able to point out in his volume on the Andamans, that in that remote region it was possible to study from its very beginning how a caste began, and this study might be expected to continue as a result of future census reports.

Captain C. E. Luard, I.A., said his connection with the "Gazetteer" related to only a small section of India, namely, the Native States in Central India. The author had referred to the great expansion which had taken place in the various articles written. Central India was a good instance of that, the articles having been expanded from 20 pages to 400, and sufficient material was left for 1,500 pages of separate State "Gazetteers." He also desired to pay a tribute to the way the States themselves assisted in the work. When the work was first commenced they were suspicious, especially with regard to the collection of statistics, the purpose for which they were to be used not being understood; but as soon as the scope of the "Gazetteer" was thoroughly grasped, no difficulty was experienced, and great

interest was taken by many of the chiefs in the historical portion of the work. The Maharaja Sindhia not only assisted energetically in the volume dealing with the statistics and history of Gwalior, but sanctioned the issue of three other volumes, the first giving a complete list of the villages in the State, both in English and the vernacular, with information regarding post and telegraph offices, and the best means of reaching the villages. A second volume contained views of all the important places in the State, while an atlas volume formed the third, containing maps on a large scale of all the districts in the State. A large collection of over 700 inscriptions throughout Central India was also made. Another thing the "Gazetteer" assisted in doing was to give the Native States a stimulus to search old records. All the old records of Indore relating to Ahalya Bai were being carefully collected, and would, he hoped, at some time be published. The co-operation which the native chiefs so heartily gave was only one of the results (so noticeable during the last 20 years) of the wider horizon and of the growing idea of Imperialism, the native chiefs now looking upon themselves, not only as the aristocracy of India, but as rulers of units in the British Empire.

Sir Thomas H. Holdich, K.C.M.G., K.C.I.E., C.B., as a very humble contributor to the descriptive portion of the "Gazetteer," thought that it was very hard to get away from Sir William Hunter, there being something about his writing in the original "Gazetteer" which was absolutely inspiring. Where his descriptions of that vast and varied country occasionally failed in accuracy, they lost absolutely nothing in magnificence. Such a contribution as he was able to give to the "Gazetteer" made immensely for its popularity; and in a work which was to cover so vast an extent of knowledge as that which was contained within the three corners of India, it was a great point that the "Gazetteer" should be so written and issued that the public generally might take a large interest in it. Reference had been made by the Chairman to the danger of there being a certain amount of apathy in personal research, owing to the facility with which nowadays information could be obtained from gazetteers or encyclopædias. If the Chairman had had the opportunity, as he had on the previous day, of listening to the story which Lord Ronaldshay, a young member of Parliament, who had wandered through Northern India and Western China, and who was a complete gazetteer in himself, gave, he thought he would agree with him that in future there was not much chance that Indian and Eastern matters generally would be discussed in Parliament by people who did not know what they were talking about. It was a hopeful sign of the times that young men who hoped hereafter to have a political career at home, generally began that career by laying a solid foundation of general knowledge by travelling abroad within the limits of those vast possessions which constituted the British Empire.

Mr. C. W. McMinn (late Bengal Civil Service) desired to call attention to the earlier labourers in the field of the "Gazetteer," who he did not think had received sufficient recognition. Surgeon-General Balfour published, not in 1863 but in 1870, a "Cyclopædia of India," in three volumes, which apparently very few people had seen. He believed an edition was published as recently as 1886, which contained a mass of most valuable information about India. He had purchased a number of copies of that book and distributed them among the libraries of India, because he knew of no better book giving an account of the country. In addition to Balfour, two gentlemen named Milburn and Macgregor published huge books about India—one in 1812 and the other in 1848. One of them was printed by order of Parliament, and contained masses of information which had been probably more or less utilised in the production of the present "Gazetteer." While he did not wish to indulge in any eulogy, the most interesting gazetteer to read was, in his opinion, the one which bore on the title page the name of Sir Alfred Lyall—the "Gazetteer" of the Berar Province. Personally, he edited the "Gazetteer" of Oudh as far back as 1868. Everyone must admit that there was a great improvement in the present "Gazetteer" over the former ones, very much of which was due to the conscientious labour bestowed upon it by Mr. Cotton, Mr. Meyer, and the other gentlemen concerned. He hoped it would be generally referred to in future, but that it would be was very dubious. The statement had been made that Members of Parliament nowadays spoke with very great knowledge and information concerning Indian matters. Within the last ten days he had seen reports of discussions in the House, in which there was a grave mistake in the facts in every four lines of the speech. He cordially endorsed the opinions which had been expressed about the valuable work which had been produced, the only regret he wished to express being that there were no illustrations. He thought that a photograph of Mr. Cotton on the title page would be a great improvement.

Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., thought that while praise was being bestowed upon the able fathers and distant ancestors of the "Gazetteer," the work that the East India Company did had been forgotten. Buchanan Hamilton was directed by the East India Company to prepare a "Gazetteer," which the India Office hesitated to publish, a digest of it being subsequently published by Montgomery Martin. He thought in discussing the question it should be remembered that the East India Company did begin the work; at all events they gave a foretaste of what had since been done by the Indian Government.

Colonel C. E. Yate, C.S.I., C.M.G., wished, as the Chief Commissioner of Baluchistan at the time the

"Gazetteer" was being prepared, to say how much he appreciated the reference the author had made to the work done by Mr. Hughes-Buller. The work there was almost entirely new, and, as Mr. Burn said, Mr. Hughes Buller had to train his own men and send them out as explorers, and certainly his work on the "Gazetteer" of Baluchistan was deserving of commendation. He thought it would be of interest if the author would state whether the "Gazetteer" of the Persian Gulf, which was started by Lord Curzon, had been completed or not; and if so, whether its was to be published, or kept secret and confidential, as he was lately informed was to be the case.

Mr. J. S. Cotton said it would be his duty to convey to his friend the author and his other friends and colleagues in India the cordial way in which the paper had been received. The audience would probably desire to know what was the present position with regard to the publication of the work. The first three volumes came out last summer, and since then he had been continuously hard at work upon the enterprise. He was now in a position to state that the fourth volume of the Indian Empire, namely, that dealing with History, was entirely complete and in page form, and only waiting for the index, binding, and maps to be bound up with it. Some ten or twelve volumes of the Alphabetical Series were in the same advanced condition, and might easily be published by the end of next month. In addition to the Atlas, which was to contain 64 maps, and a great deal of information of all sorts and kinds, it had been decided to publish in the Alphabetical Series a map of each province where a provincial article was described. He was afraid there would be no illustrations, not even portraits. Then there would be ten more volumes; and at the rate at which the printers were now working he did not see why they should not be finished, as far as he was concerned, in three or four months from now, although of course they might not be published immediately. It might be expected that he would say something also with regard to the Provincial volumes. It was an important part of the undertaking that the articles relating to any one special province, or group of States, should be collected and bound up together, so that they might be utilised either by the official in India, or by the individual in this country who wished to have the complete account of, say Bombay, in one or two volumes before him. There would be, he thought, twenty-six Provincial volumes, of which two-thirds were actually printed; and a dozen or more of those would be ready for use within a couple of months, or some such reasonable time. It might seem a discourtesy if he were not to take the only opportunity that had presented itself of expressing the thanks which were due from him to the special contributors with whom he was brought into contact, chiefly in the Historical volume, and also to some extent in the earlier Descriptive volume. He would especially mention the name of Sir Joseph Hooker, who, in the eighty-eighth year of his age, undertook to write a summary of the Botany of India, compiled from his larger work in seven volumes, which would remain a standard chapter for all time. He wished also to mention the name of Dr. Blanford, who died before the proof of his chapter upon the Fauna of India could be sent to him. He had not seen any reference to that subject in any notice of the book; but in his humble judgment it was the best short summary of the beasts, birds, fishes, and reptiles of India that had been produced. He wished to put those thanks on record on the present occasion as an example of the great services that had been rendered by distinguished men towards the compilation of such a great work.

The Chairman, in proposing a hearty vote of thanks to Mr. Burn for his paper, which he requested Mr. Foster to convey to the author, said the paper had drawn attention to the great storehouse of knowledge and information which the "Gazetteer" contained, and was most opportune in every way.

The resolution having been carried unanimously, the meeting terminated.

TWELFTH ORDINARY MEETING.

Wednesday, February 26th, 1908; The Hon. Richard Clere Parsons, M.A., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Durham, Frank Rogers, A.M.I.C.E., 11, Orsett-terrace, W.

Heath, Charles Emanuel, 66, Herne-hill-road, Herne-hill, S.E.

Maxwell, Francis Taylor, Rochville, Connecticut, U.S.A.

Stephen, Miss Frances E. V., 48, Westmoreland-road, Westbourne-park, W.

Sykes, Miss Ella Constance, Elcombs, Lyndhurst, Hants.

The following candidates were balloted for and duly elected members of the Society:—

Devare, Harischandra Keroba, Lady Jamsetjee-road, Dadar, Bombay, India.

Hayne, Frederick William, 17, Cornwall-gardens, S.W.

Hughes, M. J., Warri, Southern Nigeria, West Africa.

Luard, Captain C. E., 20, Elm-tree-road, St. John's-wood, N.W.

McKinney, Hugh Giffen, M.R.C.S., Nafada, Northern Nigeria, West Africa.

Maxwell-Lefroy, Evelyn, Coromandel P.O., Southern India.

Powles, Henry H. P., 90, Oakley-street, Chelsea, S.W.

Tickner, Thomas Francis, F.R.I.B.A., High-street-chambers, Coventry, and Stoke-green, Coventry.

The paper read was—

THE PROBLEM OF ROAD CONSTRUCTION WITH A VIEW TO MODERN AND FUTURE REQUIREMENTS.

By H. S. Hele-Shaw, LL.D., F.R.S., and Douglas Mackenzie.

It is a mere truism to say that the roads of a country are a matter of national importance. Nevertheless, it is a fact that the roads, at any rate in this country, have been allowed at certain periods to fall into a condition of great neglect, and to have become utterly unsuited to the requirements of traffic. From the time when the first real roads were constructed in this country by the Romans down to the present day, there have been periods of activity in the matter of road construction and maintenance, alternating with periods in which the roads have been allowed to fall into decay.

Turnpike legislation, introduced in the reign of Charles II., led to the passing of between five and six hundred Acts of Parliament, without, however, resulting in any permanent and effective policy which would ensure that roads were constructed and maintained so as to meet the growing requirements of an ever-increasing population. The work of Metcalf, Telford, and Macadam did, it is true, result in great road improvement, but the introduction of railways dealt a serious blow at the Turnpike system, with the natural result that a large number of roads fell into neglect. Subsequent legislative changes led to somewhat improved conditions, but it may be said without fear of contradiction, that the roads of the country, both in their condition and nature, though possibly suited to the moderate amount of horse-drawn traffic of ten years ago, have now been found to be totally unsuitable to carry the rapidly growing number of motor vehicles for which they are required to-day.

Quite apart from the mechanical features of road locomotion, involving a necessity of reform in road construction, there is the underlying cause of the increase in the use of roads to-day, the cause in question being the growth of railway traffic itself.

One of the authors, in a paper written for the Institution of Mechanical Engineers nearly eight years ago, pointed out that, while the iron roads were truly the arteries and veins of the nation, and had as such received great attention, very much less consideration had been given to the ordinary roads, which might be considered as the capillaries, or feeders, and which were just as vital to the satisfactory working of the system of internal transport as a whole.

The object of the present paper is to consider the problem of road construction, and particularly as to how far the various improvements in the methods of road-making which have been devised and put into operation since the passing of the Light Locomotives Act of 1896 satisfy modern requirements. Also what progress the various new systems of road construction have made towards standardization of modern-road making comparable with that arrived at by the pioneers, Telford, Macadam, and others in their day, for the traffic conditions of their day.

As long as the speed of vehicles was slow, the axle load moderate, and the tractive effort was not derived from the wheel itself, the surface of a road even when carrying a considerable amount of traffic could be kept in fairly good condition by means of a moderate annual expenditure, even when the surface was not very hard, nor the substance of it impervious to moisture.

Under the changed conditions of to-day, however, the increased expenditure has been so great as justly to alarm the County and Borough Councils, Urban and Rural authorities, and other bodies throughout the whole country responsible for the use of the roads.

Mr. Howard Humphreys in a paper read recently before the Society of Road Traction Engineers, gave some valuable data on the subject. Some of these facts are worth summarising. Thus the increase of cost in main roads, in thirteen years, from 1892 to 1905, had risen from $1\frac{1}{2}$ millions per annum to $2\frac{1}{2}$ millions, or an increase of 66·66 per cent. The urban and rural roads, between the twelve months ending March 31st, 1896, showed the cost of 25,650 miles of main road to be £1,778,791, or £68·34 per mile; ten years later (that is last year), the cost of 27,380 miles of main road was £2,478,481, or £90·51 per mile, being an increase of 30·51 per cent. Taking specific cases from three counties — Hertfordshire, Essex and Berkshire—the increased cost per annum per mile of road was, in one case, from

£97 to £193; in another case, from £76 to £168; in another case, from £101 to £170; and in another case from £63 to £99. In the county of Hampshire the cost of maintenance has risen in ten years from £28,000 to £65,000. In the County of Kent, in seven years, the macadam used has risen from 41,531 tons to 69,275 tons. These are only a few instances taken from the records furnished by the county surveyors, but they all tell the same tale, and that tale is one which can only be heard with the gravest concern, since from it two things are quite evident.

1. That the rate-paying possibilities in country districts will not be equal to a much further rise in expenditure, even if they can continue to meet the charge at the figure to which it has risen to at present.

2. That so far from having reached a state of finality in regard to motor traffic, the increase in expenditure is merely due (or to a large extent due) to what might be called light motor traffic. Heavy motor traffic is yet in a comparatively undeveloped state, with possible increase before it far exceeding that of the future of light traffic.

It is not to be wondered at that public attention is being attracted to a matter which touches everyone so vitally, though it is probable that the dust nuisance—as it is very properly called—has really had more to do with the public interest in the road question than the matter of the increased cost of their upkeep, though, as will be shown, the efficient road must really be, as a natural concomitant, a dustless one.

Proposals have recently been made for the nationalisation of the roads, and only the other day deputations to the Chancellor of the Exchequer concerning the future alteration in the system of taxation of motor vehicles urged that revenues from such a source should be devoted to road improvement and maintenance. With these questions the present paper does not deal, but rather with the equally important one as to what is the best way of dealing with road construction from the engineering point of view, so as to secure the most efficient road at the lowest cost.

There is only one really sound way of approaching the problem of construction, and that is to regard the road as one element of a mechanical contrivance, of which the wheel is the other element. This aspect of the matter seems too often to be entirely overlooked. Inventors of a wheel and the makers of a road, respectively, too often treat their part of the problem without reference to the other part, whereas these parts are only two halves of a whole.

More than thirty years ago there was translated from the German, by Professor (now Sir Alexander) Kennedy, the "Kinematics of Machinery," of Professor Reuleaux, and in that work for the first time the true conception of a machine was set forth. We now realise that the action of a rope on a pulley, water in a hydraulic system, or a wheel on a road, might be considered as much cases of machinal action as that of the two-tooth wheels working in contact with each other. It was truly said in the above work: "A machine may be perfect, or may contain more or fewer imperfections; it approaches perfection just in proportion as it corresponds to what we have recognised as its special object—the special end for which it has been constructed."

Now the special end for which two elements in the case of a pair (a higher pair as it is called in the case of rolling contact), viz., the wheel and the road, are designed, is that they may run smoothly and in contact with each other, resisting considerable mutual pressures without permanent deformation and without undue wear or loss of energy. The ideal condition of things is obviously that in which a perfectly hard and perfectly circular wheel runs on a perfectly hard and level road. It might be said, therefore, that a steel wheel and a steel road would be suitable as in the case of railway practice. As a matter of fact, quite apart from the practical question of the cost of such a road, there are questions of adhesion, in the matter of gradients as well as steering, that make a metal road quite out of the question. Assuming then that a really hard road cannot be obtained, it may be at once said that if a moderately hard road could be kept level and entirely free from all unevenness of surface, there could be nothing better than a truly circular metal wheel, and such a wheel being cheap and durable would doubtless be universally employed.

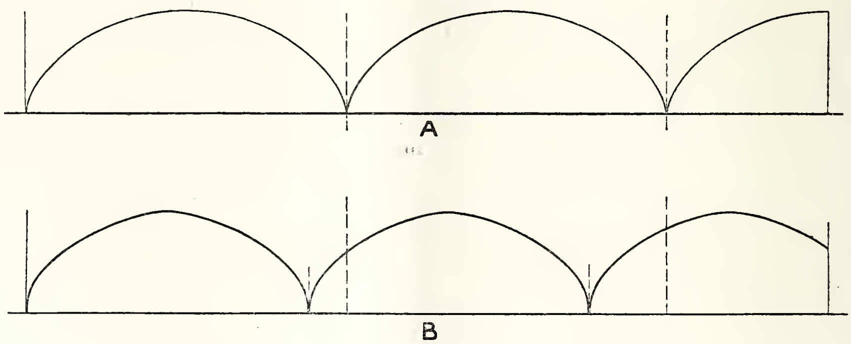
But a thing so desirable as a truly level surface is exactly what it is impossible to maintain, and it is in order to mitigate the shocks caused by the tendency to deflect a vehicle from its movement in the straight course, that yielding material such as solid rubber or pneumatic tyres are employed on the periphery of a wheel. Now we cannot employ this soft material without paying the penalty, not merely of wearing the wheel but of wearing the road itself, and as a matter of fact in so much as the

contact between the wheel and the road departs from a point in the side elevation, or a line looked at in plan, by so much is wear between the surfaces in contact introduced. In the next place let us consider what goes on beneath the surface. If the road is not hard, then a certain amount of deformation must take place.

Quite apart from the question of irregularities on the surface, which will not be considered, the difference between the perfect rolling of a hard wheel on a smooth surface, in the case where either the wheel or the road, or both, are soft, demands attention in the study of road construction.

In Fig. 1, two diagrams are shown, A representing the path on a point in the periphery of a wheel, when true rolling occurs, and B representing the path, when, owing to the ground being soft, the rolling is accompanied by a certain amount of slip at the surface. As a matter of fact, there are really four cases as shown in Fig. 2, A being the case of perfect rolling, B being the case of a soft wheel on hard ground, C being the case of a hard wheel on soft ground, and, D, the case of a soft wheel on soft ground. In all cases except A there occur both (1) deformation either temporary or permanently of particles of one or both of the bodies in contact, and (2) slipping of the surfaces of the wheel and road respectively over each other.

FIG. 1.



The injury done by this deformation will depend on two things:—

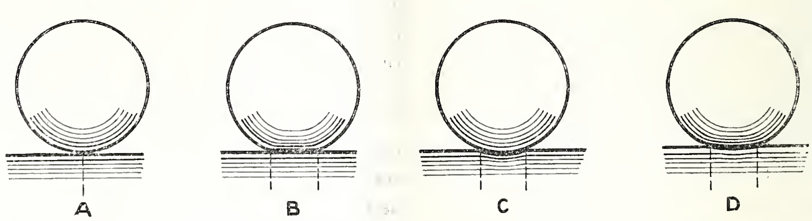
(1) The depth to which it will extend (*i.e.*, magnitude of deformation).

(2) The extent of permanent disintegration of the internal substance of the road.

It is obvious from the foregoing remarks that both as far as the surface is concerned, and also the body of the road, what is required is a tough elastic material, or if on the score of expense it is impossible to have such a material for the whole of the road, then the material of which the road is actually composed should be cemented or bound together by such a material.

In any case as the road is exposed to the action of the weather one of the very first conditions of its efficiency is that it must be waterproof, and that the surface must be sufficiently hard to prevent as much as possible the formation of liquid material—let us call it mud—in wet weather, and loose, finely-divided particles —let us say dust—in dry weather.

FIG. 2.



The sort of effects taking place can be well seen by means of lantern models, devised by one of the authors, which show the disintegrating action on the material, both in the wheel and the surface of the road. These working models enable us to realise that not only is a waterproof road with a tough and

durable surface valuable because it prevents the formation of dust and mud, but for the even more important reason that a dustless road is necessarily a waterproof one, and if the interstices are filled with some tough material, the bodily destruction of the road is to a great extent prevented, and the road becomes an ideal one.

Now there are three types of roads in use, viz., asphalt, wood and stone and, there is no doubt that either of the two first much more nearly fulfil the requirements of a perfect road than the last, but it is not proposed to discuss their merits or demerits, or compare them in detail, since there is one factor that puts them entirely out of the question for anything but town use—and that factor is their cost.

Stone roads are of two types, one being the paved road, and the other, macadam. Paved roads are sometimes used in the country for long stretches, and when once laid down, last for many years with comparatively little cost for upkeep and repair. This is, however, only the case when no particular attention is paid to the surface of such a paved road being level. Want of evenness on the surface is not of material consequence if the traffic is only slow and horse-drawn. Such an uneven surface, however, is out of the question for motor traffic of any kind, and especially heavy motor traffic, and there are roads in northern counties, *e.g.*, in Lancashire, on the outskirts of several towns, which, quite apart from the terrible noise resulting from their use by heavy motor vehicles, result in excessive depreciation of such vehicles, especially when solid steel or iron tyres are used. Paved stone roads, even with modern improvements, represented by "Kleinpfluster," "Durax," or other new systems, do not seem likely ever to become the standard type of road for general use.

Let us now see what has been done in the way of experimenting with materials suitable for road construction on these lines. The conditions must first be laid down, namely—first, that the road must be of as hard a stone as can be obtained at a reasonable cost; secondly, the spaces between the stone must be filled with a material of as nearly the same nature as the stone itself; and, thirdly, the whole road crust must be bound together by something better than the dried mud which was the practice during the Telford-Macadam era.

In America, and afterwards in this country, experiments were made with oiled roads, where crude oil was cheap, and any result was better than the loose sand of which the roads were originally composed. This was thought to be a success, but it was found that the crude oils washed out into the streams and poisoned the fish; that there was always an unpleasant aroma from these roads, and that the oil did not bind the material with sufficient tenacity to resist really heavy traffic. The use of tar has marked a great advance, but has led to some very contradictory results. The good examples showed a mosaic surface, where the tar had been absorbed by the dried mud between the stones, and had helped to form this into a tenacious compact binding material. The unsuccessful results generally showed that the presence of moisture on the road or other injurious causes had prevented the penetration of the tar into the substance of the road itself, and it had consequently formed a carpet over the surface. This carpet was liquid in summer and exceedingly brittle in winter, and was far from a suitable material to stand the attrition of road traffic. It, therefore, ground up into the most objectionable black slime, which was the cause of serious injury to the carpets and floors of roadside houses, the boots and dresses of all wayfarers, and the varnish and paint work of carriages. The uncertainty of the results led the Roads Improvement Association to conduct some experiments a year ago in order to ascertain whether mechanical applications of tar, or tar preparations, could be regulated so as to give better results. These experiments undoubtedly proved that there were compositions free from most of the objections that could be urged against crude or distilled tar, but it was also clearly demonstrated that the application of tar to road surfaces was only a palliative, and a very expensive one at that, and that it would be necessary to look for an improvement in the road construction for a permanently beneficial result.

Some excellent materials have been specially introduced, and have given very good results, but the majority of them are very expensive, and the first cost of such a road has militated against their adoption. The name of Hooley will always be associated with the initiation of waterproof road materials, as Mr. H. Purnell Hooley, the county surveyor of Nottinghamshire, is practically the apostle of this type of road. His district abounds in ironworks, and the vast heaps of slag, resulting from the production of pig iron, have

long been drawn on for material for road foundations. This slag was admittedly too soft and friable a material to make satisfactory road surfaces, and Mr. Hooley suggested it should be impregnated with tar.

The essence of his system consists in heating the slag to a temperature sufficient to drive off all moisture; then breaking it to the size of road material, and finally immersing it in tar whilst still hot. Tar oils filter to the very centre of each piece, and the tougher ingredients of the tar remain on the surface to act as a binder when the slag is consolidated under the steam roller. Many miles of the main roads in Nottinghamshire and other counties have been coated with this material, to which the name of "Tarmac" has been applied, and the greatly increased life of the road was a revelation to those who first studied the question of dustless roads. "Tarmac" has, however, one marked fault, namely, that it produces a very slippery mud, due to the fact that the slag wears to a very fine state of sub-division, and does not produce a gritty detritus as is the case with granite. Other inventors experimented with different forms of limestone and granite in order to find a material to which tar would easily adhere. One successful modification is known as "Tarlithic," which consists of blue Fifeshire granite, bound together by refined tar.

The extensive use of tar in conjunction with the above and other materials has, however, proved that the evil of tar lies in the changes that it shows at different temperatures. On a hot summer day the tar becomes almost liquid, but on a cold winter day it is a hard, brittle substance, which breaks up under horses' shoes or steel-tyred wheels to a very fine state of subdivision, making the most objectionable dust on a dry day and an even more objectionable mud on a wet day. Many investigators, therefore, have attacked the problem of treating tar, so as to produce a resultant material of a more suitable nature, and these materials have been produced and sold under patented names which fulfil most of the ideal conditions for which we are seeking.

The Northern Quarries Company have evolved a road system called "Quarrite." In Quarrite roads the binder is a toughened tar which is never either soft or brittle under ordinary English temperatures. The same may be said of Clare's Tar Compo, Plascom, Tarvia, Taafalt, and Marbit, and any of these can be used either to penetrate the surface of an existing road, or as the adhesive binder in a properly constructed waterproof road. It is, however, essential that these materials should be used as thinly as possible, just as the best results of the use of gum for joining two pieces of paper or of glue for joining two pieces of wood are obtained when the gum or glue respectively is used very thinly. When stone is laid upon a road and spread by hand, the interstices between the separate stones occupy 48 per cent. of the total volume. After the stone has been dry rolled by a steam roller these spaces occupy 40 per cent. of the volume. It would be false economy to expect bituminous binding material to fill all these spaces, and therefore most of the inventors of these materials advise that small pieces of the road material should be stirred up with the binder, and spread over the surface, so as to fill the interstices.

The objection to most of these materials is the increased first cost of the road, and up to two years ago it was the general opinion of all who had studied the subject that waterproof roads must cost at least twice as much as the old waterbound roads, so far as first cost was concerned, although it was admitted that the increased life of the road would justify this expense.

It has been left to the surveyor of one of our rural districts, Mr. A. Gladwell, to prove that a dustless road need cost but a very small amount more than the old waterbound roads by applying the binding material in a novel manner. He uses a suitable tar preparation, such as any of the above, to make a matrix of fine granite chippings mixed in this tar preparation. He lays this matrix on the old surface of the worn road to a depth of $\frac{1}{2}$ to $\frac{3}{4}$ inch. He then spreads the broken road stone on the top of this to a thickness not exceeding 4 inches, and rolls it immediately with a steam-roller. The roller forces the stone down into the matrix, and squeezes up the matrix into the interstices, and, if they have been laid in the right proportion, a little rolling will bring the matrix almost up to the surface. A small quantity of matrix can now be laid over the surface, and brushed in, and a final rolling will produce a thoroughly waterproof surface. The cost of this system need not exceed $2\frac{1}{2}$ pence per super. yard above the cost of a similar coating of granite on the old waterbound system, and it is known that it will last twice as long, and with more favourable conditions, possibly from three, five, to even seven times as long. Mr. Gladwell has thus

produced a system of road construction that is applicable to all the roads of this country, and will enable surveyors to use local material, if it is not of too soft a nature, and to produce roads that will be unaffected by the temperature or by the weather, and strong enough to carry anything in reason that may be put upon them. At the same time, the stones will be securely held in position, and there will be no dry mud to be sucked out of the interstices by the pneumatic tyres of motor-cars. It looks as if the destruction of the roads by motor-cars can thus be completely obviated, and almost the only source of wear to this kind of road surface will be the attrition of horseshoes and the steel tyres of horse-drawn vehicles. The rolling contact made by self-propelled traffic on rubber tyres seems likely to produce little appreciable wear or injury to such surfaces, and its waterproof nature saves any necessity for scraping or scavenging other than that which nature supplies by occasional heavy rain storms.

The foregoing somewhat brief general review conveys very little idea of the amount of work which has been done on the whole of this important subject, since road surveyors all over the country have been at work conducting practical experiments of the greatest value. But enough has been said to make it probable that as a result of all this work a system of road construction will ultimately be evolved, which will be able to meet the present and future requirements of motor traffic. The system of Mr. Gladwell is the latest and apparently the most satisfactory. The authors have had no hesitation in speaking of it in warm terms, and they would support the Roads Improvement Association, who have recently issued a pamphlet, giving a description of it and advocating its adoption.

It should be said that this system is not in any way protected by patent rights, and there is a large range in the choice of different binding materials which can be adopted in connection with it. It may not, of course, represent finality, and it is obvious that in each district there may be certain modifications depending upon the material available, and the peculiarities of local traffic, but at any rate it appears to the authors to offer the best solution yet proposed for a standardised system of road construction, at reasonable first cost, and only moderate charges for maintenance.

Having devoted considerable space to the road, something must be said about the other element working in conjunction with it, *viz.*, the wheel. Restrictions have very properly been devised and are enforced by law with a view of protecting the roads from undue destruction by wheels; but it is clear that just as there are demands made for road improvement on the one hand, so will demands be made and vigorously voiced for further restrictions in the matter of wheels on the other. The use of studded tyres is a case in point, and the authors think that, concerning its use, road surveyors have a just grievance at the present time. A new studded tyre with projecting steel studs and rotated by an engine of 40 to 60 horse-power, is capable, in passing along the road, especially in climbing hills at a high rate of speed, of doing a considerable amount of damage to the surface of a road, and when scores, if not hundreds, of such tyres pass along one piece of road in a day, it is obvious that there is no road surface, unless made of steel itself, that would not be cut to pieces in a short time by such means.

With regard to the types of heavy commercial vehicles, it is certain that unless the diameter of their wheels is increased, they will form, as this class of traffic increases in future, a very serious problem to the road constructor. It is astonishing how much the injury to a road surface is reduced by the comparatively small increase in the size of wheels of steam tractors, which only average about 4 ft. 6 in. in diameter, as against 3 ft. 6 in. of a heavy motor vehicle. Of course, even better comparative results are obtained with the much larger wheels of the heavy traction engine, and the anthors do not think it is going too far to say that if the wheels of such traction engines were not of the size they are, the passage of one such traction engine on a road, in certain states of the weather, drawing of course its full load, would be sufficient to do incalculable damage, that is, assuming it were able to pull its load at all. The authors do not wish to enter farther into the question of the wheel. They have drawn attention to some of the chief points which are of pressing importance in the matter of road construction, and wish, in conclusion, to remark that while they have shown that there must be sympathetic co-operation between the designer of the wheels of a motor vehicle, and the surveyor who is responsible for the maintenance of the road, there is a third party, who has a serious responsibility in the matter, namely, the user of the road.

However good the road, and, however well

designed are the wheels, a great responsibility must rest with the driver of a motor vehicle. By the incessant use of the crown of the road, leading to tracking, by the injudicious use of brakes, by the rushing of corners at unreasonable speeds, and in many other ways, the driver of a motor vehicle can do more damage in a week to the roads, as well as to the vehicle he is responsible for, than would be otherwise the result of twelve months fair usage. The authors trust they have shown that if the drivers and manufacturers do their part, the science of road construction has now advanced sufficiently for the road surveyor to be able to do his part without putting an undue and even prohibitive burden upon the community.

DISCUSSION.

Mr. DOUGLAS MACKENZIE said there seemed to be a general impression among the population of the country that road construction as a science had stood still for many years. It was quite true that it had done so from the days of Telford and Macadam until recently, but that was mainly due to the fact that the railway was taking the traffic off the road, and that the amount of merchandise to be conveyed along it was infinitely less in quantity than it used to be. But since the motor-car had been invented and new traffic had come upon the roads steady progress had been made in the science of road construction. Every surveyor throughout the country who had any length of road entrusted to his care had been carrying out experiments to ascertain how to construct dustless and waterproof roads without throwing an undue burden upon the ratepayer. He felt he was not justified in carrying out very extensive alterations in his road system unless he knew that they would result in permanent improvements. There must be slow, steady and gradual progress if real progress was to be made. He, therefore, thought a great deal of injustice had been done to road surveyors, because the public had not recognised the quiet but persistent way in which they had been endeavouring to meet the demand for a road that would suit an entirely new traffic. Surveyors were now learning that they could construct really good and satisfactory roads that met all requirements with regard to dustlessness and durability at a cost that would not be excessive, although it was bound to be slightly greater than on those roads constructed on the water-bound system. He was bound to admit they would cost more in the first instance, but the increased durability of the road would lead to such a longer life that the actual annual expenditure, averaged on a large number of miles of road, would be reduced by such a system instead of increased, *i.e.*, by the adoption of a satisfactory waterproof material, the road rates would be actually lowered. He believed that the waterproof roads would cost not more than 10 per cent. more, but they would last at least twice as long as the water-bound roads. So far they had not been able to wear out a properly constructed waterproof road, so that it was impossible to say definitely how long it would last, but it was known that the surface had worn so slightly that its increased life was enormous, and road engineers felt justified in saying it would last three, four, and even seven times longer in some cases, and yet cost only 10 per cent. more than the old system. That would mean an immense saving to a large county with several hundreds of miles of roads. All the roads could not be reconstructed in one year, the usual system being to schedule certain roads for reconstruction in a particular year. If the county surveyor scheduled in future 10 per cent. less than he did under the old system, he would only spend exactly the same amount on the new system, and at the end of seven or eight years the whole of the roads under his charge would be reconstructed. Although at the end of that time some of them would need re-coating, the length of mileage which would have to be done would be very much less than if the roads had been constructed under the old system. Another result learned from the experiment was that dust palliatives were worse than useless, and they lasted such a short time that the enormous cost was a serious burden. Even if the material was laid down on a road which had a light traffic, at the end of the summer no trace of it could be found. If the length of road that was treated experimentally by the Roads Improvement Association between Hounslow and Staines was inspected, although in certain places a permanent benefit could be detected, it would be necessary to go round with a microscope to trace any tar. It was necessary to start steadily and systematically to re-construct the roads with dustless material, and the sooner the Highways Committees realised that fact the easier would be the work for the county surveyors, and the more satisfactory to all concerned would be the results they produced. He believed gentlemen were present who could state that the results of their experiments had proved to them that they could make satisfactory dustless roads at a comparatively small cost, and that if their Committees would allow them to proceed on that system they hoped ultimately to reduce the Highways Rate.

The CHAIRMAN thought the paper was a most important one, bearing in mind the fact that the length of roads in this country was so enormous. In 1870, the President of the Institution of Civil Engineers, Mr. Charles Vignoles, stated that the length of metalled roads in the United Kingdom amounted to 160,000 miles. Supposing £5,000 a mile had been spent in the construction of those roads, including the cost of land, it meant that in times past 800 million pounds had been sunk in the roads of the country. In 1870, the capital of the railways of the country amounted

to 530 millions, so that the roads at that time were probably of greater value than the railways. Since that time, however, the railways had advanced at a very fast rate, and their traffic had enormously increased, while until lately the traffic on the roads had decreased. In addition to that, speeds had become enormously greater. A speed of six or eight miles an hour when horse drawn traffic was run on the roads was considered a high one, although the old coaches went up to ten miles an hour; but now motor cars were allowed by law to travel at twenty miles an hour, and very frequently travelled at double that pace. It could therefore be readily understood that the surface of roads which were constructed to take traffic at six or seven miles an hour was not likely to stand the wear and tear of traffic at twenty, thirty, and forty miles an hour. Most people thought that a nice soft pneumatic tyre did no damage to the roads, but the reverse was the fact. He could not help thinking, however, that the explanation Dr. Hele-Shaw had given of the damage done by the pneumatic tyre was not at all equal to what it really was. The first point noticed on the roads was that deep holes were very quickly caused. After carefully examining the tracks left behind by a heavy motor-car, he had noticed that in the small holes which had commenced in the roads, and which were full of water, after the car had gone over them there was not a vestige of water, mud, or small stones remaining, as they flew out on both sides because of the enormous hydraulic force produced. The holes then filled up again with mud, more cars came along, and the hole was again pumped out. The depression also had the effect of making the car jump, so that it came down a little distance off, and a corrugated road was the result. That produced a very intense scouring action, which he thought was vastly greater than any rubbing action which took place, as described in the diagrams. If the size of the wheel was increased, the tendency to deepen the hole would be very considerably reduced. He could not help thinking that the diameter of the wheels of motor-cars were too small, probably because the cost of the tyres was so excessively high; but if the wheels could be increased in size, the roads would be undoubtedly be saved a great deal of wear.

Colonel R. E. B. CROMPTON, C.B., said he disagreed with a great deal the Chairman had said as to the excessive action of the motor-car tyre being the cause of corrugations in the road, which, from his observation, occurred from totally different causes. Ten or fifteen years ago anything was good enough for a road from the point of view of the road surveyor. All that was necessary was to get a steam roller, and roll rocks, mud, houses that had been recently destroyed, including the beams and woodwork, into the road, with the consequence that a road was obtained which had a smooth surface for a short time, but was made up of such a heterogeneous mass of materials that, under the influence of the English climate, the soft materials were removed, and the roads wore badly. There was no doubt about it that, at that period, the roads of this country were very much worse than at an earlier period, when closer attention was paid to the choice of the metal, and no rollers were used, the material simply being consolidated under the rolling action of the wheels of the traffic. He desired to corroborate the authors' remark that a good deal of the trouble could be overcome by increasing the diameters of the wheels of vehicles. The difference in the effect on the roads of large diameter wheels was surprising. Although there were exceptions, the authors' statement was perfectly correct that traction engines did very little damage to the roads, most of the damage being done by the small-wheeled wagons they dragged behind them. He had used traction engines in a yard for years, and it kept in perfect order, requiring no repair; but as soon as the loaded train used the yard it immediately cut away the metalling. If heavy traffic was to be accommodated on the roads of England, much larger wheels would have to be adopted. The modern constructor imagined that, as the diameter of the wheels was increased, the weight was also increased to such an extent that it was quite out of the question for him to throw away so much useful load by increasing the tare weight of his wagons, thus reducing the net load that he could carry at a profit. At one time he was of the same opinion, but after recently going carefully into the matter, he had been surprised at the results obtained if wheels were designed in accordance with the much abused Local Government Board regulations as to the width of tyre and the modifications of load carried according to the diameter. Anyone approaching the problem for the first time would probably say that the weight of the wheels themselves increased as the square of the diameter. That was not the case. They increased as the diameter, or rather less than the diameter. The law was that about 11 times the diameter of the wheels in inches gave the weight in pounds of the wheel itself; and once that law was well known it was quite possible commercially to use wheels up to six feet in diameter without any excessive increase in weight, and on gradients up to about 1 in 10 the user was a gainer in spite of the increased tare of the wagons. The authors had conveyed a very false impression by stating that tar-spraying as a palliative was useless. Personally, he was one of the judges in the tar-spraying experiment, and probably went over the road more than anyone else did. It was said that the system was a failure because it was expensive. The cost of Mr. Gladwell's system was about 1s. 6d. a square yard. Taking a good existing road, like the new London road through Chelmsford, which was about 8 yards wide, to have reconstructed it on the Gladwell system would have cost a considerable sum of money; but at the beginning of the year it was treated with tar at a cost of £40 a mile, and the road was now in a most perfect condition, simply because the tar was put on

carefully and at the right time. Therefore, for a cost of less than £40 a mile, everything had been done to make the road perfect, so far as the inhabitants were concerned, by utterly suppressing the mud and dust nuisance, which was a considerable saving, because it costs £30 a mile per year to water the roads. If tar spray was properly done on a road already in good condition, and was put on at the right time, it was not a palliative only, but an enormous improvement, and it made many roads quite as good as the Gladwell system, for a period of one year. The experiments carried on in the previous year were conducted under unfavourable conditions. The trials showed that some of the machines were better than others for laying the tar properly, but none of the makers had appreciated the fact that they did not lay it in sufficient quantity. When the materials were tested, it was found some of them were so much superior to others that there was no comparison between them, most of the patented articles being superior to the ordinary tar. Tar taken from the gas works, although it was called "refined" was quite unsuitable to put on roads, there being materials in it that were soluble in water, which came out of the tar, and poisoned the water in the ditches. Two or three of the patented compounds quite got over that difficulty, and they were being used with excellent results by Mr. Gladwell. He desired to supplement one or two of the authors' statements by saying that one of the most important things was the temperature of the rolled surface. If the specific heat of the material was not studied, a deposit of white hoar-frost might be found on the roads in the morning, which made them slippery and dangerous. The perfect road surveyor was the man who used perfect material, who knew how to use it, and how to take advantage of its qualities, so that he did not get a deposit of frost in the early morning. Mr. Gladwell, Mr. Manning, and other gentlemen had succeeded in doing that at a small cost. He thought the authors were to be thanked for bringing forward a subject which indicated that the country was on the eve of a complete revolution in the construction of its roads, and that, at no serious charge to the finances of the community, dustless roads in summer and mudless roads in winter could be obtained, so that it would be possible for the people to have the pleasure of motoring, cycling, horse driving, or walking without any of the annoyances at present existing.

Mr. A. Gladwell desired to say that an absolutely dustless road had never been constructed, and never would be constructed. The utmost that could be done was to construct a road which should be non-dust producing, so far as its own structure was concerned. The percentage of voids in an unrolled surface was about 48, which could be reduced to 33 per cent. by careful rolling, *i.e.*, there were voids equal to 33 per cent. of the total volume of material put on the road. What those voids were to be filled with was a subject worthy of the road engineer's study, just as the selection of the aggregate was. The secret of good road construction was to study every part of the road and not simply one separate portion. It was no good having 66 per cent. of the materials of the road of the best possible material available, and the other 33 per cent. anything which happened to come along which might be cheap. The authors, in referring to his system, did not say anything about the surface sealing of the road, which was practically a complement of the process. He had constructed a section of road without surface sealing, and he was carefully watching its behaviour. It behaved fairly well so far as being waterproof was concerned, but he noticed in travelling over it that a certain amount of tractive effort was wasted in the fact that the road was a little bumpy; but the advantage was distinctly in favour of surface sealing, which cost about $1\frac{3}{4}$d. to 2d. per super yard. Road engineers were naturally very much concerned at the inconsiderate use of the road by road users. It was not at all encouraging to find that, although the roads were constructed with as flat a cross-sectional contour as they could be made, the traffic, probably from force of habit, still insisted on keeping the middle track, when the sides of the road were equally available. He did not see why the ordinary road user should not educate himself up to using the whole width of the road impartially. That would tend to economy, and would give a much fairer use of the road than was the case at present, when probably the middle track took 80 per cent. of the whole of the traffic. That tended to the deformation of the road, and expedited the day when repairs had to be effected, while the equally good sides of the road had not had a wheel on them for a week. The question was such a serious one in the interests of the community, that he hoped the Government would take the matter up; and if the road user and everybody else would do their share, he was sure the road engineer would not be found wanting. A fair amount of traction engine traffic had passed over the roads, and he had not noticed that it had broken the crust of the roads at all. One particular road, which he prepared for inspection by the members of the Municipal County Engineers, had since the 11th May last stood traction engine traffic, and in addition the heavy Great Western motor 'buses passed over it 14 times a day.

Mr. P. J. Thomas thought the question was entirely one of £ s. d. The main roads of the country were now costing £800,000 a year more than they were six years ago. The total cost of the roads per annum in England and Wales was £7,500,000, and all the County Councils received back from the Exchequer was £1,500,000, or one-fifth. In his opinion a much greater sum than that should be paid by the Imperial Government.

Mr. F. J. Sharpe enquired whether motor-cars, as at present constructed, could be safely driven without non-skids. He had a temporary body put on a new car, and the driver drove it without a skid; but as

soon as the proper body was put on, the driver could not drive it at all, and it was necessary to put on new tyres and non-skids before it was satisfactory.

Mr. W. H. Leete said that after seeing Mr. Gladwell's experiments at Slough, he constructed a section of road at Bedford according to his system, and he was glad to say it had stood remarkably well during the winter. The one weak point in the section was that it was not quite sufficiently sealed, which he attributed to the material not being sufficiently dry; but if both the road and the material were dry he had no hesitation in saying that Mr. Gladwell's system would produce a perfectly water-tight and clean road. He had a section of the road that he laid down cut out to lay before the Automobile Club at Bedford, in order to show the behaviour of the tar and the matrix on the base, and it revealed the fact that the tar had, at the most, penetrated about one-third the depth of the material, and the flux that was poured in from the top had gone down about the depth of one stone; the middle portion of the section had not been reached by the tar He attributed that to the fact that the road was laid in the autumn (October), and the weather being cool, the tar had set before it could percolate sufficiently down. But given good weather and dry material, he was satisfied that excellent results could be produced by that method of road making. He found that roads made in the ordinary way cost 15d. per super. yard, while by Mr. Gladwell's method, a thoroughly clean, dry road was made for 1s. 6d.

On the motion of the Chairman, a hearty vote of thanks was accorded to the authors for their interesting and instructive paper.

Mr. Douglas Mackenzie, in reply, thought the Chairman had exaggerated the danger that was done by pneumatic tyres on wet roads, nor, in his opinion, was it always due to the presence of moisture. If waterproof roads were constructed, the little pools and the splashing of the water would not result in damage to the road; but if there should be slight depressions due to some deficiency in the foundation of the road, the pneumatic tyre and any other tyre which dropped into the hole would simply remove the water without removing the binding material. If roads that would stand reasonable modern traffic were to be constructed, it was useless to depend on dry mud for the binding material, which could be washed out by any water present on the road. He thought it would be agreed by all present that Dr. Hele-Shaw's explanation showed how the damage was done by a soft tyre. If a road surface could be produced which was bound together by elastic material so that the give was in the elastic material, and there was no movement between the pieces of the aggregate, the loss due to attrition would be saved. Colonel Crompton had very wisely accentuated the importance of the large diameter wheel. Personally, he had tried the experiment of increasing the diameter of the wheels of motor 'buses from 40 to 42 inches, and noticed as a result that on a private road leading to the garage there had not been so much wear as formerly. A curious feature was that the larger diameter wheels had reduced the wear on the rubber tyres to such an extent that, as soon as he was able to obtain definite and accurate results, he believed he would be able to reduce his tyre bill by $\frac{1}{8}$d. per car mile. He desired to criticise Colonel Compton's remarks with regard to the success of the tar road compared with a properly constructed waterproof road. If the work cost only £40 a mile, and the road was eight yards wide, the price worked out at $\frac{7}{8}$d. per super. yard, which was so low a price that the tar must have been used very economically. He doubted whether the whole width of the road was treated at such a price, and suggested that a less width was tarred at a cost of about $1\frac{1}{4}$d. per super. yard. If that was the case, surely it was more economical to construct the road on an approved system, costing 2d. or 3d. a yard more than the ordinary system, and thus make a structure which would last for seven or ten years rather than pay $1\frac{1}{4}$d. every year. In reply to Mr. Gladwell's remarks with regard to the amount of the voids, he thought that if the voids were reduced by dry rolling to only 33 per cent., the stone would be unduly crushed. The stone ought not to be crushed by dry rolling, and by using a somewhat fluid matrix, a good deal of that crushing was prevented. He wished Mr. Gladwell would take up a section of his road and find out exactly what the amount of voids were that were left in the section after rolling, he believed it would be found that the voids were more than 33 per cent., because the matrix had saved the crushing of a lot of the stone to powder which would have helped to reduce the voids. The subject of surface sealing was dealt with in the paper, and Dr. Hele-Shaw's illustration of applying some additional matrix or binder on the surface of the road, showed that they had taken into consideration the extreme importance of sealing the surface after the matrix had been rolled up as far as its nature would allow it to be done. He thanked Mr. Leete for emphasising the fact that road engineers were anxious to make improved roads, and now they knew it could be done without increased cost he was sure they would follow Mr. Leete's example and make waterproof—he did not say dustless—roads, which would not wear and would be very much more satisfactory from every point of view.

Mr. Leete desired to state further that the section of road he took up showed the effect of the rolling. The bottom portion of the granite was well taken up by the matrix, while the middle and top portions of the road were so closely consolidated that he was astonished to find there was scarcely a stone which had not found its billet. There were scarcely any crevices which could have been filled. The

material had gone together so compactly in the middle that it was most difficult for any mixture of tar to get amongst it, unless the weather was very dry and suitable.

Dr. HELE-SHAW, in reply to the question with regard to non-skidding tyres, said he had had practical proof of the non-skidding qualities of a front-driven petrol vehicle. Although the motor had no non-skidding devices whatever, and the roads were in a slippery and muddy condition, not the slightest trouble was experienced with skidding. He was glad Colonel Crompton had supported so strongly the suggestion that larger-sized wheels should be used. In reply to the proposal of Mr. Gladwell of the term "non-dust-producing roads," he would remark that it was not the roads which produced the dust, but the vehicles that ran upon them, and if a waterproof road was constructed he ventured to think it would be practically dustless.

OLIVE GROWING IN TUNIS.

The culture of the olive tree in Tunis dates from the time of the Romans—somewhere about the Christian era. It was prosperous until the sixth invasion of the Arabs (693-694 A.D.), when a great number of plantations were destroyed. In the year 1048 a new invasion of the Arabs took place and their tribes, of nomadic instincts destroyed systematically all the elements of sedentary life. The olive trees of the district of Sfax were entirely destroyed. No efforts were made until 1800 to 1810 to start fresh plantations. The number of olive trees in Tunis is estimated at 11,222,525. During the last ten years about 200,000 acres have been sold by the Government at about 3s. 4d. per acre, with the obligation for the purchaser to plant olive trees within four years. This will represent in the near future an increase of 1,000,000 productive olive trees. The plantations are made with cuttings from old trees, eight to ten inches long and four inches thick, to which the bark is still adhering. It is from this bark that the branches spring. The part of the trunk which has grown under the earth is reputed to be the best, but practically no attention is paid to this point. No particular care seems to be required, and they can remain without risk as long as fifteen to twenty days in the burning sun of the south. The soil in the most important olive districts is light and of a sandy reddish tint, due to the presence of oxide of iron, with a rocky subsoil. It is poor in appearance, which is confirmed by analysis. The earth proves to be abundant in potash and deficient in azotic and phosphoric acids. Earth of yellowish colour is considered poor for olive trees. The American Consul at Tunis, says that in Sfax, the most important and progressive district for olive tree planting, eating olives are of two kinds. "Mellahi," which is picked green for salting, is a round fruit which can attain the size of a small apricot, and "nab" which is oval in shape and smaller than the former. These two varieties are planted in a small proportion in each orchard, the remainder being of the "chemlali" kind. The latter is a much smaller fruit grown especially for the mill, and grows over the whole of North Africa. A variety of the "nab" of a reddish tint is grown in small quantities. Olive trees are subject to a tax varying from three-halfpence to fourpence-halfpenny each which is not applied until the tree is twenty years old. Wild trees grafted are free of tax for ten years. Two-thirds of the oil produced comes from Arab mills, where the processes are most rudimentary. Olives are picked between November and February, according to the species grown. Branches are struck with long poles, or else the fruit is picked by scraping the branches with the fingers, the latter being provided with some kind of claws. The olives are placed in a dark room and each layer of olives is covered by a layer of salt. The fruit remains in this state for three or four months, losing gradually its water, which is allowed to run into a reservoir when the small quantities of oil that escape are retrieved. Unfortunately, the fermentation resulting from these practices gives a rancid flavour to the oil which renders it unpalatable to all except the natives. The mill is a mere roller turning inside a cylindrical basin, animal power only being employed. The fruit and stone being reduced to a pulp, the mixture is spread over some flat pieces of matting, round in shape, which are made of esparto grass. These are put under a wooden press and a mixture of oil and water is extracted. As the oil rises to the surface it is pnt into earthern jars.

COPPER AND BRASS INSTITUTE.

At a meeting of copper and brass manufacturers, engineers, and others, which was held in Manchester on February 13th, 1908 (Mr. W. H. Johnson in the chair), it was unanimously resolved to form a "Copper and Brass Institute." The objects of the institute are similar to those of the "Iron and Steel Institute," viz. :—1st. To afford a means of communication between members of the trades in question, bearing upon their respective manufactures, excluding all questions connected with wages and trade regulation. 2nd. To arrange periodical meetings for the purpose of discussing practical and scientific subjects relating to the manufacture, working up and use of the non-ferrous metals.

It is not the intention of the founders to limit the institute to the copper and brass trades, but to include all those connected with the commercially important non-ferrous metals and their alloys, as lead, zinc, tin, aluminium, nickel, silver, gold, platinum, &c., and their alloys.

A meeting to define the constitution and method of procedure of the institute will be held in the Midland Hotel, Manchester, on Tuesday, March 10th, at 4 p.m., to which all those interested are invited.

HOME INDUSTRIES.

Sweated Industries.—The Sweated Industries Bill has been read a second time, and is not unlikely to become law before Parliament rises. It is seldom that a measure of equal importance, introduced by a private member, has met with such little opposition. It is supported irrespective of party, and almost unanimously, for all admit the extent and seriousness of the evil it is intended to combat, and the Bill concerns itself with that section of the community least able to protect itself. Nevertheless, it sets up a principle new to our law. It proposes a Wages Board and a minimum wage. Under it any trades union council, or six employers of workmen, would be able to petition the Home Secretary for an inquiry into a given trade; and, after this inquiry, the Home Secretary might direct that a Wages Board be established. This Board would have the power to fix a minimum wage for different classes of work, and for different districts, according to local conditions; and when once its wages was fixed, it would become a penal offence for an employer to pay less. The Home Secretary (and, therefore, the Government) supported the Bill with the very important reservation, that he would not pledge himself to the minimum wages proposal. He approves the proposed inquiries and the Board for a select number of the scheduled trades, but wants more information as to what the minimum wage ought to be. The evils of sweating are not deniable. The sweater's profits are an economic injury to the whole community. The miserable drudge who works for him comes sooner or later to the rates, and adds to the hereditary pauperism that is such a disturbing feature of the country's position. The Wages Boards established in Victoria are said to be doing useful work, but the experience of a small community like Victoria would not necessarily be our own. The Home Secretary says the case justifies experiments in legislation, and that is the justification for the Bill. It is urged by opponents of the Bill that if the employer is compelled to pay the minimum wage he will cease to employ at all, and necessitous people who earn little now will then earn nothing at all, or else there will be evasions which will reduce the law to a dead letter.

The Shipping Trade.—It is many years since the shipping trade was in such an unfavourable condition as it is to-day. Last year was a bad year for shipowners, 1908 is likely to be much worse. Last year they were helped by the abnormal demand for coal from all quarters, by the carriage of material for the rebuilding of San Francisco and Valaparaiso, the coaling of the American fleet in the Pacific, and the carriage of exceptional quantities of wheat from the Pacific ports of North America to Europe. Not only will shipowners be without these exceptional demands this year, they will have to compete with more and more foreign tonnages for the ocean trade, whilst the coasting trade of China, which used to employ so many British steamers, has been captured by the Japanese, and the coasting trade of Japan is now almost entirely in native hands. On the other hand, if this year shipowners may have cheaper money and coal, the relief in respect of the latter charge—nearly one-half of the working expenses of an ordinary cargo steamer—is not likely to be great, and they have to reckon with the new burden due to the Workmen's Compensation Act. It is too soon to say how that will affect a ship's earnings, but in the opinion of many experts the item will be a serious one. Freights are so low and expenses so high that it may be thought that shipowners would act prudently in laying up their steamers until better times, but this would mean wholly unproductive capital and heavy loss in the depreciation of machinery and boilers. The truth is there are too many ships in the water for the work required of them. There must be a reduction of the shipbuilding output for a time, but this is a serious matter for the shipbuilding and the iron and steel industries. It is very serious too from the national point of view. It looks as if the owners of the merchant tonnage of the country will get little in return this year upon their capital, and when it is remembered that the cargo carriers represent roughly a capital of £200,000,000, the seriousness of this state of affairs will be apparent.

Labour Disputes.—The engineers and the shipwrights are still in dispute with their employers, but it is earnestly to be hoped that the efforts to bring about agreement will be successful. Many trades are concerned in the present labour crisis. In the dispute with the engineers the employers asked for 5 per cent. reduction on piece rates, but afterwards modified their demand to a reduction of 2½ per cent. on piece rates and a corresponding reduction for time rates, but the men object to any reduction. There are on the north-east coast 11,500 members of the Amalgamated Society of Engineers, 1,500 members of the Steam Engine Makers' Society, and 11,000 machine workers. The aggregate number of the men employed in the shipyards, engine shops, and ship repairing works, all of which are threatened with stoppage, is 83,000. There is, however, ground for the expectation that, so far as the dispute in the engineering trade is concerned, it will be settled amicably.

Railway Electrification.—The London, Brighton and South Coast Railway Company expect to complete the electrification of their South London line from Victoria to London-bridge this year, and if this forecast is not verified it is certain that the work will be completed early in 1909. But although this work has revived interest in the problem of railway electrification here, there is no probability of any early electrification of the main long-distance railways. The position is different with the southern suburban railways. For the dense traffic in and around large cities electrification is a pressing necessity. The railways have already lost heavily by their failure to recognise in time how the greatly increased comfort and handiness of the electric trains would attract the public. It would have been well for the railway

companies concerned if they had spent the money wasted in unnecessarily frequent express long distance services of elaborate trains in providing electric service for suburban traffic.

Annuity Insurance Business.—The Royal Exchange Insurance Company has decided to do away with a curious inconsistency in so far as its own life insurance business is concerned. Ordinary policies are issued on selected lives, and if any deviation from the recognised standard of life is discovered when the proposal is submitted, the business is either declined or "rated up," that is to say, charged an additional rate. But in the case of an applicant for an annuity no inquiry is made. Obviously, if his health is bad so much the better for the company, and it would seem only fair that an impaired life should enjoy the advantages of a proportionately reduced price for the annuity. The Royal Exchange now recognises this very plain fact, and proposes to offer special terms for annuities payable on invalid lives. It is a concession that will be welcomed by many whose health is more or less precarious, and who are deterred by that knowledge from paying the ordinary consideration for a benefit which may last only for a very short period.

Trade Unions.—The report of the Chief Registrar of Friendly Societies on Trades Unions for 1907 shows the rapid progress of trade unionism and the financial strength of many of the societies. Returns were obtained from 645 trade unions with a membership of 1,719,031. This was an increase of 151,512, or 9·7 per cent., on 1905. The income in 1906 was £2,709,665, an increase of £152,485, and the expenditure £2,283,230, a decrease of £222,794 as compared with 1905. In 1886 the membership numbered 340,893; in 1906 it had increased to 1,719,031; in 1886 the income was £671,058; in 1906 it had increased to £2,709,665; in 1886 the funds amounted to £565,255; in 1906 they had increased to £5,864,342. The Amalgamated Society of Engineers, who are concerned in the north-east coast dispute, heads the list with funds amounting to £729,075. Its membership numbers 104,871; its income last year was £400,700, and its expenditure £313,084.

The Wages of Railway Servants.—A very interesting and valuable report upon the wages of railway servants has just been published by the Amalgamated Society of Railway Servants. It shows that a very large proportion of employees of the grades included receive wages ranging from 17s. to 27s. a week. More of the men get 21s. a week than any other wage. Of the men employed in the United Kingdom 38 8 per cent. get 20s. and under, 49·8 per cent. earn from 21s. to 30s. a week, and 11·4 per cent. earn 30s. and over per week. 3,200 employees get under 10s. per week, and 40, 50s. The average wages of the men is 23s. 11d. per week, and of boys 11s. 9d. There is considerable variation in the rates paid by the chief companies.

NOTES ON BOOKS.

Description of a Tonal Method of Notation, and a Special Alternate Note Keyboard in connection with the same. By P. Crawford Barlow, B.A., M.Inst.C.E.

It is universally admitted that, from the strictly scientific standpoint, the ordinary staff-notation of music is by no means flawless; and, from the seventeenth century downwards, many and various reforms have been advocated—a few of which, such as the Tonic Sol-fa system, have proved of value as temporary stepping-stones in elementary teaching, though the problem remains whether what after all is the one and only key to the whole literature of past and present music can ever be replaced by anything else, however theoretically superior. Mr. Crawford Barlow's method is, as he says, especially applicable to students of the Tonic Sol-fa, and is, in essentials, designed on the same lines, the prominent indication of the relationship of each note to the Tonic of the key being the main underlying feature. Recognising that the staff in some form is practically necessary, at any rate for instrumental music, Mr. Barlow retains the familiar conception of lines and spaces. His staff, however, consists only of four lines, divided by somewhat wide intervals, in which there are "intermediate invisible lines," visible only when notes occur on them as ledger lines. Every semitone is represented in the notation, and consequently the different degrees of the scale and the various intervals are at once clear to the eye, and the intellectual grasp of certain fundamental harmonic conceptions is facilitated.

The special keyboard, devised for use with this reformed notation, consists of alternate white and red notes, the latter being shorter and raised. The back part of such notes as correspond to the black notes on the ordinary keyboard is coloured black, and in the two cases in each octave, where black and red correspond, the red notes are slightly longer than the others of that colour (perhaps Mr. Barlow hardly realises the technical complexity caused by the existence of three distinct "striking distances" for the fingers in rapid playing). It will, of course, not be necessary to write the notation in any special key; but the lines (visible and invisible) will be numbered so that the position of the notes on the staff will show their relationship to the Tonic, and at the commencement of each staff there will be a letter giving the key (large if major, small if minor), and an "indicator" consisting of two vertical rows of small circles, one on the lines and one in the spaces, to show which will be the lines and spaces utilised in writing the degrees of the scale. Accidentals will be represented by small distinctive marks; modulation by a new "indicator" if more than transient, or, if considerably prolonged, by a new key-letter as well. (In this respect—and the same difficulty confronts Tonic Sol-fa, and indeed

all Tonal systems—a great deal of modern music, where key-methods are flexible to the point of virtual non-existence, might prove very hard to express with adequate clearness.) Right and left-hand staves will, of course, be the same, and a familiar initial crux will be thus removed.

In the absence of the special, the notation can be adapted to the ordinary keyboard without any sacrifice of the main features; but it will naturally not be possible for the mere position of the notes on the staff to indicate by itself the Tonic relationship except in the key of C, nor will the performer be able to play in any key from the same notation. Otherwise the theoretical advantages remain unimpaired.

HANDBOOK OF PHOTO-ENGRAVING. By N. S. Amstutz. Third Edition. Chicago: Inland Printer Co. 1907.

This book is founded on the previous manual on the same subject by Mr. H. Jenkins, first published about ten years ago. It deals very fully with all the various processes of photo-typography, including the three-colour process. Intaglio methods (photogravure) do not appear to be included, and for that reason the very comprehensive title adopted may appear, at all events to English readers, a little misleading.

Every department of a modern factory for the production of printing blocks is fully treated, and every stage of the process by which a drawing or a photograph from nature is converted into a block may be followed. The camera, with its various screens, mirrors, reversing devices, stops, stands, and adjustments; methods of lighting—natural and artificial; development and treatment of the negative; printing the plate, etching it, finishing, mounting, and proving it; all these and many of the other details of what is now a large and complicated commercial business, receive full attention. Copious information is given about apparatus, instruments, mechanisms, materials, and methods. The book is throughout fully illustrated.

GENERAL NOTES.

FIJI.—Sir Everard im Thurn's report on Fiji (Cd. 3729-12), gives some noteworthy figures respecting the growth of indentured imigration. In 1901 the total number of Indians in Fiji was 17,105, in 1906 it had increased to 28,540. During 1906 2,520 immigrants were introduced from Calcutta and Madras, and 321 were repatriated. The average cost of introduction for the past five years is £15 10s. 6d. Indian immigrants come to the colony for a term of ten years, the first five of which is under indenture. At the end of ten years the immigrant is entitled, with his wife and family, to a free passage to India at the expense of the general revenue. These conditions are identical with those ruling in British Guiana, where, by the way, Sir Everard im Thurn was a magistrate for a number of years. At present the three staple exports of Fiji —sugar, copra, and green fruit (chiefly bananas)—represent 98 per cent. of the total export trade of the colony. Such minor products as cocoa, rubber, fibres, &c., can be successfully grown, and there is room for considerable increase in their cultivation. One of the obstacles to the rapid development of the colony is the lack of means of communication. Beyond the immediate vicinity of the municipal boundaries of Suva and Levuka there are few roads fit for wheeled traffic, but bridle tracks exist everywhere. The principal means of communication is by water. Communication between the islands is maintained by three steamers and a fleet of 162 sailing vessels, of which 91 are owned by natives.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 4.—"Modern Dairy Practice." By LOUDON M. DOUGLAS. JAMES CANTLIE, M.A., M.B., F.R.C.S., will preside.

MARCH 11.—"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By ERNEST R. MATTHEWS, F.R.S.E.

MARCH 18.—"Impressionist Painting: its Genesis and Development." By WYNFORD DEWHURST The EARL OF PLYMOUTH, C.B., will preside.

MARCH 25.—"Recent Improvements in Decorators' Materials." By A. S. JENNINGS.

APRIL 1.—

APRIL 8.—"Technical Education in America." By SIR WILLIAM H. PREECE, K.C.B., F.R.S.

APRIL 29.—"Modern Roumania." By ALFRED STEAD, Consul-General for Roumania." SIR PERCY SANDERSON, K.C.M.G., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MARCH 12.—"Progress of Native States during the past Forty Years." By SIR DAVID W. K. BARR, K.C.S.I., Member of the Council of India. The RIGHT HON. LORD CURZON OF KEDLESTON, G.C.S.I., G.C.I.E., will preside.

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MARCH 24.—"The Mineral Resources of Western Australia." By the HON. C. H. RASON, Agent-General for Western Australia.

APRIL 7.—"The Imperial Problem of Asiatic Immigration." By RICHARD JEBB.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

March 31.—"Enamel Portraits." By Cyril Davenport, F.S.A. Sir Hubert von Herkomer, C.V.O., R.A., will preside.

April 28.—"Lace as a Modern Industry." By Miss Isemonger. Alan S. Cole, C.B., will preside.

May 26.—

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Professor Vivian B. Lewes, "Fuel and its Future." Four Lectures.

Lecture I.—March 9.—The formation of fuel—The storage of energy during the growth of vegetation—The formation of cellulose, and its conversion into wood, peat and coal—Natural liquid and gaseous fuels.

Lecture II.—March 16.—The fuel supplies of the world—The uses of fuel and the past demand—The existing supplies and the future—The necessity for immediate economy, and the lines on which it is possible—The calorific value of our fuels, and the amount utilised in practice—Fitting fuel to the work it has to do.

Lecture III.—March 23.—The smoke problem—Bituminous coal unfitted for any coal purpose——Smokeless fuels—The question of high *versus* low temperature carbonisation in the manufacture of illuminating gas—The gas industry and its work in the future.

Lecture IV.—March 30.—The internal combustion engine *versus* steam—Gaseous fuel and power production—The utilisation of peat—The regeneration of Sun energy when our present fuel supplies are exhausted—Alcohol as a fuel, and its possibilities.

William Burton, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.

May 4, 11, 18.

Shaw Lectures on Industrial Hygiene.

Tuesday and Friday evenings, at 8 o'clock :—

March 17 (Tuesday).—"Child Workers and Wage Earners." By Miss Nettie Adler, Hon. Secretary to the Committee on Wage Earning Children.

May 15 (Friday).—"The Dangers of Coal Dust and their Prevention." By W. E. Garforth, President of the Colliery Proprietors' Association of Great Britain.

Howard Lectures.

Thursday evenings, at 8 o'clock :—

H. S. Hele-Shaw, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

March 19, 26, April 2.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 2...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. A. J. Metcalfe, "The Treatment and Formation of Roads."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Professor Edward Hull, "The Atlantic Islands, and Origin of their Fauna."

Entomological, 11, Chandos-street, W., 8 p.m.

Chemical Industry, Chemical Society's Rooms, Burlington-house, W., 8 p.m.

Tuesday, March 3...Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Stirling, "Membranes: their Structure, Uses, and Products." (Lecture IV.)

Alpine Club, 23, Savile-row, W., 8½ p.m

Civil Engineers, 25, Great George-street. S.W., 8 p.m. Discussion to be re-opened by Lieut.-Col. H. A. Yorke, on Mr. William Barclay Parsons paper, "The New York Rapid-Transit Subway."

Zoological, 3, Hanover-square, W., 8½ p.m.

Civil and Mechanical Engineers, Caxton-hall, Westminster, S.W., 8 p.m. Mr. A. S. E. Ackermann, "Notes on Engineering Works in Austria and Bosnia."

Wednesday, March 4...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. L. M. Douglas, "Modern Dairy Practice."

Geological, Burlington-house, W., 8 p.m.

Royal Archæological Institute, 20, Hanover-square, W., 4½ p.m. Mr. Albert Hartshorne, "Holdenby Manor, Church and House."

Thursday, March 5...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Professor F. E. Weiss, "The Morphology of *Stigmaria*, in comparison with recent Lycopodiaceae." 2. Mr. Alexander Patience, "*Trichoniscoides albidus* and *T. Sarsi*."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. H. Hartley and N. P. Campbell, "The Solubility of Iodine in Water." 2. Miss C. de B. Evans, "Traces of a new Tin-group Element in Thorianite."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir John Rhys, "Early British History and Epigraphy." (Lecture I.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Prof. A. Schwartz and Mr. W. H. James, "Fuse Phenomena."

Friday, March 6...Royal Institution, Albemarle-street, W., 9 p.m. Prof. John Milne, "Recent Earthquakes."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) 1. Mr. R. V. Morris, "Surveying on Thunder Bay Branch of the Grand Trunk Pacific Railway, Canada." 2. Mr. William Graham, "British Practice in Railway Surveying." 3. Mr. W. C. Crawford, "Railway Surveying in Great Britain."

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m.

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. P. L. Forbes, "Water Colour Drawing and Architecture."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, March 7...Royal Institution, Albemarle-street, W., 3 p.m. Professor J. J. Thomson, "Electric Discharges through Gases." (Lecture I.)

Journal of the Royal Society of Arts

No. 2,885. VOL. LVI.

FRIDAY, MARCH 6, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 9, 8 p.m. (Cantor Lecture.) PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." (Lecture I.)

WEDNESDAY, MARCH 11, 8 p.m. (Ordinary Meeting.) ERNEST R. MATTHEWS, "The Use of Reinforced Concrete in Engineering and Architectural Construction in America."

THURSDAY, MARCH 12, 4.30 p.m. (Indian Section.) SIR DAVID W. KEITH BARR, K.C.S.I., "Progress in the Native States of India during the Past Forty Years."

Further details of the Society's meetings will be found at the end of this number.

PRESENTATION OF THE ALBERT MEDAL TO LORD CROMER.

The Council of the Royal Society of Arts attended at Marlborough House on Tuesday, the 3rd inst., when His Royal Highness the Prince of Wales, President of the Society, presented its Albert Medal to the Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., "In recognition of his pre-eminent public services in Egypt, where he has imparted security to the relations of this country with the East, has established justice, restored order and prosperity, and by the initiation of great works, has opened up new fields for enterprise."

The members of the Council present were:—Sir Steuart Colvin Bayley, K.C.S.I. (Chairman), Lord Blyth, Sir William Bousfield, LL.D., Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Sir William Crookes, D.Sc., F.R.S., Henry Hardinge Cunynghame, C.B., Francis Elgar, LL.D., F.R.S., Hon. Sir Charles W. Fremantle, K.C.B., Henry Graham Harris, Sir Charles Augustus Hartley, K.C.M.G., Colonel H. C. L. Holden, R.A., F.R.S., Sir John Cameron Lamb, C.B., C.M.G., Sir William Lee Warner, K.C.S.I., Sir Philip Magnus, M.P., Sir William Preece, K.C.B., F.R.S., Sir Boverton Redwood, D.Sc., Sir Owen Roberts, D.C.L., Alexander Siemens, Carmichael Thomas, Professor John Millar Thomson, LL.D., F.R.S., Sir William Hood Treacher, K.C.M.G., with Sir Henry Trueman Wood, M.A. (Secretary), and Henry B. Wheatley (Assistant Secretary).

SHAW LECTURES.

On Friday evening, February 28th, Dr. JOHN SCOTT HALDANE, F.R.S., delivered the fourth Shaw Lecture on "The Removal of Dust and Fumes in Factories."

The lecture will be published in a future number of the *Journal*.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1908 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before Saturday the 4th April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of

which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures. and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential services in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce, by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of our several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world,"

In 1885, to Mr. (afterwards Sir) Henry Doulton,

"in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry —the utilisation of waste silk."

In 1887, to HER MAJESTY QUEEN VICTORIA, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce, through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar, a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the applicatiou of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy, in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph (now Lord) Lister, F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries by which not only has the art of surgery been greatly promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his metallurgical researches and the resulting development of the iron and steel industries."

In 1896, to Prof. David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce, by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

In 1897, to George James Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years systematic observations (now at over 3,000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S., "in recognition of his numerous and most valuable applications of Chemistry and Physics to the Arts and to Manufactures."

In 1899, to Sir William Crookes, F.R.S., "for his extensive and laborious researches in chemistry and in physics; researches which have, in many instances, developed into useful practical applications in the Arts and Manufactures."

In 1900, to Henry Wilde, F.R.S., "for the discovery and practical demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small, a discovery now used in all dynamo machines; and for its application to the production of the electric search-light, and to the electro-deposition of metals from their solutions."

In 1901, to HIS MAJESTY THE KING, "in recognition of the aid rendered by His Majesty to Arts, Manufactures, and Commerce during thirty-eight years' Presidency of the Society of Arts, by undertaking the direction of important exhibitions in this country and the executive control of British representation at International Exhibitions abroad, and also by many other services to the cause of British Industry."

In 1902, to Professor Alexander Graham Bell, "for his invention of the Telephone."

In 1903, to Sir Charles Augustus Hartley, K.C.M.G., "in recognition of his services, extending over 44 years, as Engineer to the International Commission of the Danube, which have resulted in the opening up of the navigation of that river to ships of all nations, and of his similar services, extending over 20 years, as British Commissioner on the International Technical Commission of the Suez Canal."

In 1904, to Walter Crane, "in recognition of the services he has rendered to Art and Industry by awakening popular interest in Decorative Art and Craftsmanship, and by promoting the recognition of English Art in the form most material to the commercial prosperity of the country."

In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S., "in recognition of the influence which his researches directed to the increase of scientific know-

ledge, have had upon industrial progress by facilitating amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for Sound Signalling at Sea."

In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S., "for the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing."

In 1907, to the Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., "in recognition of his preeminent public services in Egypt, where he has imparted security to the relations of this country with the East, has established justice, restored order and prosperity, and by the initiation of great works has opened up new fields for enterprise."

PROCEEDINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday afternoon, February 18th; WALTER CRANE, R.W.S., in the chair.

The paper read was—

BANNERS IN PAGEANTRY.

By GEORGE W. EVE.

The importance of banners and flags to scenes of pageantry is sufficiently obvious. Their strong colour value, their constant movement and their significance as symbolism, combine to produce a strikingly vivacious and interesting effect. The necessity for historical accuracy in the details of scenic representations is so well recognised, that I hope no apology will be required for a few notes on a subject that is also capable of considerable expansion.

Banners, to use the word in its widest sense, are especially associated with the conditions of mediæval and subsequent times; for although in the ensigns of antiquity, flying drapery was sometimes added to the modelled device which formed the essential part of the ensign, such drapery was, in most cases, a mere subsidiary embellishment. The military ensigns of the Assyrians, of the Egyptians, and of the Romans, were alike in being solid objects carried on staves; those of the Romans being, of course, of most importance to pageantry in England. To some of these was added a pendant scarf or a square piece of drapery hanging from a transverse bar beneath the principal emblem, as it did beneath the cross and the sacred monogram of the banner of Constantine, in the fourth century. In northern Europe the drapery decorated with symbolic devices was itself the ensign from a very early period. Among those soonest to acquire a more stable heraldic character being the eagle of the Emperor, and in a lesser degree the raven banner of the Danes. Like other devices of an heraldic nature, banners and flags were more or less fanciful for a considerable period until at last they had a special character and became regularised in common with other heraldic bearings in the twelfth and thirteenth centuries. They naturally followed the same course of evolution as the armorial shields, being at first charged with badges whose use was more or less fixed according to circumstances, sometimes acquiring a character of permanence to finally develop into the regular arms.

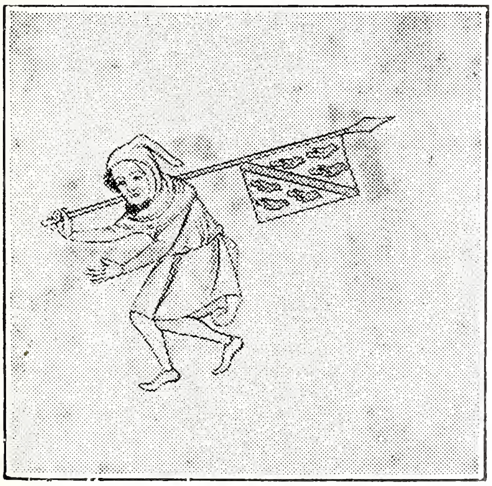
At the time of the Conquest the principal banners were such as were expressly intended to further the business in hand, and such was the banner of William of Normandy, which was consecrated by his brother Odo, the Bishop, and is represented in the Conqueror's hand in the Bayeux tapestry. As there shown it is not a banner at all as we understand the word, but is a lance pennon of four points, nevertheless it has a certain squareness due to a sort of square border which encloses the cross. Indeed there is nothing in the whole of that historic embroidery to indicate that anything more than lance pennons of various shapes were in use at the time, although there can be little doubt that more important flags must have existed. Probably the conditions of shape and size of the embroidery influenced the design in this way. The only device that is larger than the lance pennons is what may be intended for another representation of the sacred banner. It appears in the shape of a solid square fixed to the masthead of William's ship. It has a border and cross like those on the pennon, and is surmounted by another and smaller cross raised on a mound. No representation exists of the banner of King Harold, but it is said to have borne the figure of a man fighting.

Down to a late period of the twelfth century, therefore, we shall not find many authentic personal heraldic bearings in the pageantry of war or of peace. Even after the regular development of heraldry into a system, the non-armorial banners were of occasional use, and as late as 1567 a pictorial banner was with the army of the confederated lords to whom Mary Queen of Scots surrendered at

Carbery Hill, on which appeared a man lying dead on the ground, and with the motto, "Judge and avenge my cause, O Lord!" In obvious allusion to the murdered Darnley.

In the regular arrangement of the heraldic system banners naturally became subject to rules which governed their size and shape and bearings in relation to the rights and rank of their bearers. The principal forms are the pennon, the standard, and the banner, and of these the last is of most importance. In shape it was always rectangular, though the proportions of height to width—or of hoist to fly, as it is called in naval language—varied considerably. In the earlier examples, from

Fig. 1.*



the thirteenth to the fifteenth centuries, banners were usually very high in proportion to their width, in many instances being twice as high as they were wide, but by the end of the fifteenth century they had become more nearly square. A quaint figure from an early fourteenth century MS. shows the shape of a banner at that time (Fig. 1).

But whatever the usual proportion may have been at a given period, the early designer treated his banner with the same commonsense regard for practical conditions that characterised his dealings with other heraldic subjects, and did not hesitate even to reverse the proportion to suit a special need. An instance of such reversal occurs in a fifteenth century MS. of Froissart's Chronicles, where a St. George requiring a long horizontal space in which to slay the dragon in front of him, has the banner lengthened from staff to fly in the proportion of about 3 to 2.

* These blocks are kindly lent by the Proprietors of the *Daily Graphic.*

Such instances were, however, exceptional, and the general shape of banners at the period I have indicated was that of a parallelogram with its long side to the staff, a very suitable shape for bearings that had been originally designed to fill a shield-space.

Technically speaking, a banner is defined as a rectangular flag bearing the arms over its whole surface as a shield does, though the last condition is not without exceptions. For banners sometimes bore badges and other fanciful devices as, for instance, those charged with a dragon (of Cadwallader), and a dun cow (of Warwick), that Henry VII. gave to St. Paul's Cathedral, the banners that had been at the victory of Bosworth. It may well be, however, that these were really standards loosely described.

In foreign pageantry, banners were frequently decorated with complete armorials, including human figures which support banners within the banner, in addition to the shields of arms, crests, crowns, and other accessory insignia.

To have a banner was the privilege of barons and of those of higher rank, and in addition knights who had especially distinguished themselves were given the much coveted privilege and thus became knights banneret.

The method of creation was for the prince to take the knight's pennon, and, by tearing off the forked ends, make it square. This was done on the actual field of battle and under the Royal banner displayed, a ceremony full of chivalrous significance.

The forked shape of a knight's pennon has been mentioned, and it was in fact little more than a lance flag of considerable size, of which the split end was the distinctive part, the pennon of an esquire having but one point.

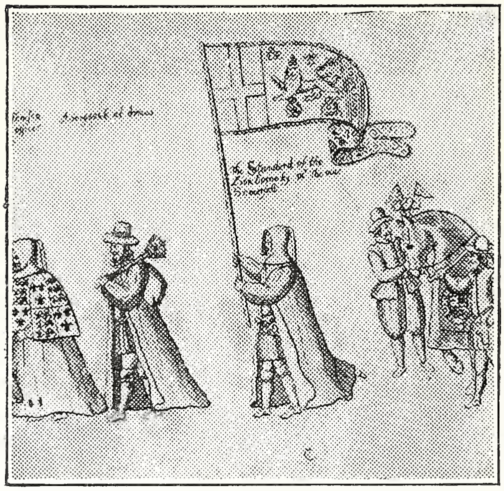
In some early instances, however, a knight appears with a curiously shaped pennon of but one point and shaped like the lower triangle of a square that has been cut across diagonally. An instance occurs about 1340.

A much larger bifurcated flag, perhaps developed from the pennon, came into use early in the fourteenth century called a standard, and thenceforward became a conspicuous element of ceremonial and battle pageantry. It was large and splendid, and in addition afforded an opportunity of commemorating facts and allusions by means of devices that could not properly be borne on the great banner which was wholly occupied by the regular arms. On

the standard could be indicated family ties and the marks of friendship or of loyalty.

The standard was a long tapering flag split into two tails as already stated, and it usually bore at its widest end next the staff the national emblem, in England the Cross of St. George, gules on its argent field, and the rest of the flag was of the livery colours of its owner, in the necessary number of horizontal divisions, and on it appeared the badge or badges many times repeated, with the motto in two diagonal stripes between them. It was, therefore, susceptible of great variety, as may be seen on those borne at the funeral of Queen Elizabeth. Of these there were three: the Standard of the Dragon, that of the Greyhound, and that of the Lion (Fig. 2).

Fig. 2.



In these the number of badges is very large and some of them bear allusion to the Queen's ancestors as far back as Edward III. That King himself had a standard with his arms, France and England quarterly next the staff, the rest of it being semé of fleurs-de-lis and lions. Another bore the figure of St. George slaying the dragon.

The historic standard is perpetuated, though much modified, in the standards of the Household Cavalry, which are bifurcated like their prototypes, but have in course of time become much shorter. Their bearings also have no similarity to those of the earlier standards.

The size of standards varied considerably according to the rank of their owners, their length at one time ranging from four yards for a knight, five yards for a baron, and so gradually increasing until that for the King was nine yards long when it was to be carried in battle, and even longer when it was to occupy a fixed position such as that before the royal tent. In any case they were of imposing size and of corresponding value to the splendour of pageantry. For sea service the flags were enormously increased in size, the great streamer of the Earl of Warwick's ship in the time of Henry VI. being 40 yards in length and 8 yards wide, more than three times the length of the flag on the tower of the Houses of Parliament.

Still another banner that is of no small importance is the trumpet banner, a small flag about 20 inches square, that is still displayed by the trumpeters of the sheriffs of counties, and by cavalry trumpeters in some cases. Its bearings are variously arranged, but in England are more usually than not borne like those of the great banner, that is to say, the arms alone cover the whole space. But there are many instances of badges and complete groups of armorials being borne on trumpet banners, and there is no essential reason to the contrary, for these decorations are only banners in name.

The ceremonial of the tournament was full of waving heraldry, banners and pennons flew from the windows of the knight's lodgings, were carried in solemn procession and placed in the hall, with their master's crested helms, for the inspection of ladies, the heralds, and the judges of the tournament. Afterwards, the banners flew over the heads of the contending knights in the combats of the tourney itself. In the early fifteenth century such decoration was at its height, and the profusion is amply evident in the illuminated MSS. of the time.

Banners were naturally conspicuous in the royal processions of all kinds, but it is when we come to those of the early sixteenth century that we find pageantry at its utmost magnificence. And great artists—Durer and Burgkmair among others—gave an added splendour in their wonderful representations of the processions and triumphal arches that they had themselves designed. Some of these remarkable displays were brilliant expressions of that rivalry in luxury, as in power, between Henry VIII., Francis I., and the Emperors Maximilian and Charles V., which made so much of the history of the period. The triumphal arch that was designed for Maximilian, by Durer, and the triumphal procession, as represented in the series of woodcuts, by Hans Burgkmair, stand out as marvellous examples of prolific invention and powerful draughtsmanship, as well as con-

vincing proof of the splendour of the times. And the procession that accompanied the entry of Pope Clement, and the Emperor Charles V. into Bologna was not inferior in dignity, though it is represented to us by artists of lesser rank.

The materials of which banners were made are many. Silk, satin, velvet, linen, and worsted having all been employed under suitable conditions. The more sumptuous banners were made of thick, six-thread silk, the much-prized samit. Cendal and other thinner silks were also used, especially in later times when the banners had become of huge size, such as those in the sixteenth century which are seen, at least 12 feet high, held by one hand at the end of very short staves, so that they must have been very light indeed.

The bearings were embroidered in various kinds of needlework in gold and colour, sometimes indeed with pearls and other jewels. Henry III. had a standard of red samit, embroidered with a golden dragon, whose eyes were made of sapphires and other precious stones. Sometimes goldsmiths' work in thin metal was sewn on to the banners as it was on the garments of the period.

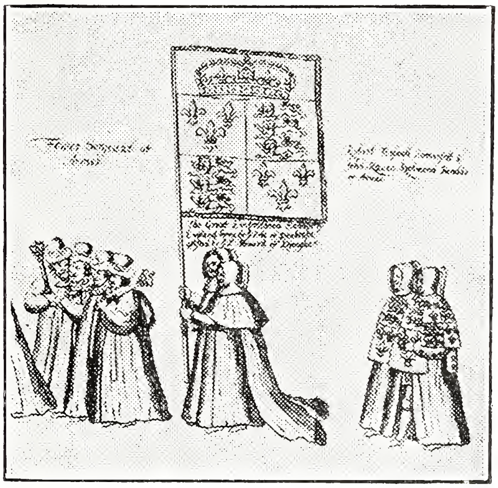
The most usual method was that which is undoubtedly the right one as being perfectly suitable to the materials and character of the object, and was the kind of flat embroidery that was known as *opus consutum*, cutwork, or as we say *appliqué*. The charges were cut out of the material of the proper colour and were sewn down to a ground, the field of the arms, and the outline was couched with cord which helped to define the forms and to express such simple details as were necessary. And the result was to produce a very simple and broad effect that was expressively heraldic and flaglike. Few examples remain of early banners but there is one in the Royal Armoury at Stockholm which is made in this way, and though a slide of it is not available I shall be able to show you examples of the method as applied to other heraldic drapery, which will further explain the character of the work. Among them being an interesting coloured slide, showing a piece of a surcoat in *appliqué* linen, for which I am indebted to the kindness of Mr. Cyril Davenport.

Banners were also painted or part painted and part embroidered. Painted imitations of embroidery were very prevalent in the fourteenth century, as the result of an attempt to evade the laws against luxury which were enacted at the time, forbidding, among other things, the use of embroidery to those below a certain rank. Such painted versions were themselves confiscated later on.

Among the painted banners of the fifteenth century were some that were made for Joan of Arc by the King's order, and one of them, painted with her portrait and with that of Charles VII., is still, I believe, to be seen at Orleans.

When one thinks of a painted banner, the thing that comes into mind is that with which we are familiar in the Lord Mayor's Show, painted in oil in the modern manner, and, moreover, brightly varnished, until it looks like a combination of coloured tin and silk. But the effect of the earlier work must

Fig. 3.



have been altogether different, for in it tempera painting was employed, at least, down to the sixteenth century, and was probably varnished over with oil, which dried into the colour and left a pleasant surface that was not incongruous with embroidery.

With the development of oil painting as we know it, the painting of banners increased until it at last superseded the beautiful needlework nearly altogether, and so general had the practice become by the middle of the sixteenth century that when a banner was embroidered special mention was made of the fact. This occurred with regard to the Great Banner of England that was borne at the funeral of Edward VI., and at that of Queen Elizabeth (Fig. 3). The inclusion of the Crown was very unusual in English practice.

After the end of the sixteenth century art in banners, as in other heraldic objects, is hardly

worth consideration until we reach the time of the revival that is still comparatively recent.

Embroidery is, without doubt, the means of expressing heraldry that fully satisfies the conditions of emblazoned drapery, and even through the worst periods this has been felt, for the Sovereign's banner in St. George's Chapel, Windsor, has always been embroidered, while the banners of the Knights Companion of the Order of the Garter were painted. The King's banner that now hangs over the Sovereign's stall was beautifully worked on the proper lines of flat *appliqué* by the Royal School of Art Needlework. Another notable instance of embroidered banner work are the large number of finely-executed banners of the Order of St. Michael and St. George in St. Paul's Cathedral, which have been worked, under the direction of Mr. St. John Hope, by the Decorative Needlework Society.

The arms on a banner must be drawn exactly as they are borne on the shield, with only such modifications of spacing and proportion as the shape of the space requires. The lions and similar animals are directed towards the side next the staff, so that when the banner advances, blown backwards by the wind, the animals appear to advance too.

With regard to the proportion, distribution, and treatment of the charges on banners, it must be understood that the primary requirement of heraldic design is complete legibility, and this is of especial importance in a form of heraldry which must be distinguishable at a distance, and that in spite of the movement which, while an important element in their picturesque effect, tends to obscure their bearings. Such legibility depends, in a great measure, on decorative distribution, the arrangement of figures in relation to their containing space in such a way that the decoration is complete, while the proportion between the charges and their field is such as to secure clear and expressive definition. When this is satisfactorily effected, it will be found that complete legibility and decorative quality imply each other. Just balance is by no means easy of attainment however, and the useful direction to "fill the space," which was so necessary, as a protest against a mean and ineffective way of designing heraldry, does not go far enough in explanation, while it may go too far in encouraging exaggeration of charges at the expense of the field. This was what happened in some of the decadent Gothic work of the early fifteenth century where lions appear so packed into their spaces that they leave little more than a thickish line of the ground visible. The result, besides the clumsy effect that was produced, was to defeat the definition at a distance which size is expected to secure; whereas a banner that depends for its legibility on well-arranged colour masses will always be effective.

The very nature of the subject renders any attempt to formulate rules of proportion out of the question, and the only guide, when the qualities to be aimed at are once known, must be a sense of spacing without which all decorative design is hopeless.

Characterisation should be strong and clear, and be expressed in drawing that is simple in character but of strong and expressive line.

It should also be remembered that heraldic animals should be drawn with the utmost spirit attainable, that just as the early draughtsman was less concerned with the form than with the rage and courage that it was intended to express, so we shall not forget that vigour is of the essence of heraldic beasts, and we shall depict our lions "in a fury" instead of feebly posing them like stuffed skins. Finally, the quality of the material must be preserved to the full, and then we may confidently expect a satisfactory banner to result.

[The lantern slides included views showing the use of banners at sea and in the tournament.]

DISCUSSION.

The CHAIRMAN (Mr. Walter Crane) thought the drift of the author's artistic lesson was to show the great value of decorative spacing in heraldic designs for banners and standards. It was a curious thing that in the present generally considered democratic age something like a renaissance of heraldic design was going on. The subject was now being seriously studied in schools of design, and with the help of men like Mr. Eve he did not doubt that a very great improvement in badges and heraldic devices of all sorts would result. It did not at all follow that, because the country became more democratic, the use and value of heraldry declined, although it might be used in a less personal and more collective sense. On the contrary, it appeared that every organisation of a social, political, industrial, or municipal character at once demanded some distinctive badge; many of the most interesting and beautiful devices known in heraldry were attached to some of the old cities and monasteries, to say nothing of the distinctive character of the national emblem. He had often felt that, in its original form, the splendid national Royal Standard was one of the things which required new treatment.

He would very much like to see all the old flags called in, and a new set issued under the direction of the reader of the paper. The lions, or yellow leopards in the first and last quarters, always seemed to him to fill the field insufficiently, and suffered very badly in comparison with the very fine examples of the thirteenth and fourteenth centuries which Mr. Eve had shown, the modern ones answering his happy description of an attempt to represent a lion by means of a spiritless, lifeless, stuffed specimen, instead of a ramping, raging, noble creature of the imagination. He thought such papers as the present one ought to do a very great deal of good in calling attention to the importance of the subject, and it was to be hoped that Mr. Eve would carry on his work until a more general sense of education on the subject was obtained. There was one field of banner design not touched on by the author which might be said to have a sort of really popular life, though he feared Mr. Eve would consider the existing examples altogether too pictorial, viz., the workmen's banners which were often elaborate and considered of enormous importance by the corporations which bore them on occasions of popular meetings in public places, more particularly the banners of various trades unions and labour federations. As a rule, they were certainly not remarkable as works of art, but at the same time there was a sort of spirit of the old idea, a practical use of the banner signalising the most important thing in the minds of the corporations and associations which rallied round them and bore them to the front. Both Mr. Henry Holliday and himself had designed labour banners he might say, and they had endeavoured to apply the heraldic principle to modern purposes. The main group on such banners very frequently represented two workmen shaking hands, and a good deal of machinery, which one would have thought was impossible of decorative treatment, was often thrown in the background. In fact, there was nothing too daring for the pictorial banner painter of the present day. If he can only be induced to look at his work in the heraldic spirit, some very splendid results would be seen; but nothing was more difficult to eradicate in these islands than bad traditions.

Mr. H. Stannus said he had been in hopes that a pageant might have been held in London during the present year, and if it had taken place, some of the author's beautiful banner work would probably have been seen; but he understood that difficulties had arisen in connection with the obtaining of a site, and that the pageant would not be held. The author had spoken of the necessity for clearness of the proportion between the charges and the field. Anything like equality would be disastrous, because either the charge must be larger than the quantity of the field or *vice-versâ*. Another point which the author had not touched upon, probably because he had taken it for granted, was that of colour. In dealing with banners, the heraldic rule had to be remembered that there must never be a metal put upon a metal, nor a colour upon a colour. If a metal was put upon a metal, both the charge and the ground shone, making them indistinct; and the same occurred when colour was put upon colour. He wished the author had touched more upon the *gonfalon*, because he could not help thinking that that was the right way to use heraldic charges or badges of any kind in processions. One of the difficulties connected with a banner was that it could not always be held displayed, which detracted from its use. In processions he had often observed the stripes of red, white and blue, and knew it was the Union Jack because he had seen it so often; but in the case of a banner containing arms with which one was not familiar, if the banner was crumpled with the hanging of the banner it would not be clear. Last Lord Mayor's Show was admirable for its splendid pageantry, and he there noticed that the banners were fastened to the stick or pole, and appeared to have a thin metal pole to hold them displayed, which enabled the spectators to see the banners clearly. But obviously the use of such a metal rod was more a concession to the British public than to heraldry; and he could not help thinking, therefore, that the proportion the author had suggested of making the banner higher than it was broad would be better, because obviously banners made to those proportions could not droop so much. He thought the author's statement, "That the principal banners were such as were expressly intended to further the business in hand" was at the root of a great deal of banner work. The banner which was displayed at Carbery Hill, by raising the just indignation of deluded subjects, undoubtedly did further the business in hand.

Mr. Eve, in reply, said that the question of colour on colour and metal on metal was usually taken for granted; so that unless an author was writing a treatise from the beginning of heraldry he would assume that there would be no possibility of mistake in that direction. He had dealt with the subject with a view to making the paper useful to those who were designing modern pageants and other historical representations, and he therefore assumed they were working upon information already acquired, and carrying out sketches which would be furnished to them by experts. In a different way, the same line of thought applied to the *gonfalon* and to the banner which was artificially extended at the top. It seemed to him that that was a perfectly legitimate way of displaying a banner, but it would hardly be sufficiently historic to adopt in what was usually an historic representation. The same remark applied to the question of the proportion of the banners. He quite agreed that the perpendicular banner, a banner which was high rather than wide, did lend itself infinitely better to display than the long banner, the conception of which was due very much to the Navy. He supposed the Navy was so much more able to rely upon a breeze that they treated it as constant; but there was no doubt that the proportion of banner which had

been adopted by the Navy, and varied from time to time by it, had always been in the direction of length of fly. That was all very well when simple flags, such as signal flags or Union Jacks or flags with straight lines, were being dealt with; but when heraldic banners, containing figures, lions or anything else, came under consideration, then the naval proportion of two parts in length to one in height became utterly impossible. Nevertheless it was to be remembered that the proportion was not at all obligatory on land, and was not followed. The colours of the army and the banners used on shore in forts were of a different proportion altogether, being still longer than their height, but not so long as the sea pattern. Mr. Eve replied in the negative to Mr. Stannus's inquiry if there was a proper canonical length for such colours, and further stated that the length was prescribed by Departmental orders, in exactly the same way as the depth of the soldier's collar; it was a matter of tailoring taste at the time. He quite agreed with the Chairman's remark, that trade banners might be made extremely decorative and decoratively correct, although not necessarily heraldic. He was sure Mr. Crane would agree with him that the figures of Workmen, of Virtues, or Aspirations, or anything of that kind, should in such cases be treated decoratively, in a banner-like way, and not too pictorially.

The CHAIRMAN, in proposing a hearty vote of thanks to Mr. Eve for his exceedingly interesting paper, desired to correct one remark made by Mr. Stannus by saying that the London Pageant had simply been postponed to next year, he understood, chiefly because it would prove so strong an attraction that there would not be much chance for the Exhibitions at Shepherd's-bush and Earl's-court if it were opened this year.

The resolution of thanks was carried unanimously.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 4th, 1908; JAMES CANTLIE, M.A., M.B., F.R.C.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Aird, James Erskine, Deundi Tea Estate, Lalchand P.O., Sylhet, India.

Eldridge, T. J., care of Imperial Maritime Customs, Shanghai, China.

Gascoyne, George, 83, Charlwood-street, S.W.

Gee, Charles Douglas, Assoc.M.Inst.C.E., office of 1st Division, Lower Bari Doab Canal, Lahore, Punjab, India.

Hanson, David, Salterlie, Halifax.

Keates, William Francis, Cannelton, Indiana, U.S.A.

The following candidates were balloted for and duly elected members of the Society:—

Coldwell, Christopher Benjamin, Lucknow Waterworks (Aish-Bagh), Lucknow, India.

Dudhoria, Bijoy Sing, Azimganj, District Murshidabad, Bengal, India.

Irving, Joseph, Assoc.Inst.M.M., the Mono-Baltic Mining and Smelting Company, Ironton, Colorado, U.S.A.

Kincaid, Major-General William, care of Messrs. Alexander, Fletcher and Co., 2, St. Helen's-place, E.C.

Leighton, Professor Gerald Rowley, M.D., C.M., F.R.S.E., Sunnyside, Russell-place, Trinity, Edinburgh.

Lewkowitsch, J., Ph.D., M.A., F.I.C., 71, Priory-road, N.W.

Runton, Percy T., A.R.I.B.A., Victoria-chambers, Bowlalley-lane, Hull.

Sanderson, Sir Percy, K.C.M.G., 65, Wimpole-street, W.

The paper read was—

MODERN DAIRY PRACTICE.

By LOUDON M. DOUGLAS.

The dairy industry is on the eve of great alteration in consequence of a widely-spread propaganda, which has been gathering in force during recent years. From many quarters attacks have been made upon the procedure in connection with modern dairy practice, and it is only right to say that the majority of these attacks have been justified. The attitude of the milk producer at the present moment may be set down as hostile to the recognition of the results arrived at by scientific investigation. It is stated, for example, in a recent paper read before the Farmers' Club, that amongst the causes which contributed to the great attention at present being paid to the milk supply may be mentioned "exaggerated statements contained in sensational articles appearing in a section of the Press as to the conditions under which milk is produced, and the dangers attending its consumption." It is only right to say that no proof whatever is given of the exaggerated statements referred to, and I have been unable to find in any of the newspaper articles indicated justification for this statement. On the other hand, it has been clearly shown by such investigators as Dr. E. C. Schroeder that the milk supply is constantly being contaminated with tuberculous germs derived from cows which to all appearances are in a healthy condition. It has also been

found that 91 per cent. of the people who die, are affected to a more or less degree with tuberculosis, although that may not be the immediate cause of death. Considering, therefore, that this disease is so prevalent everywhere and that it may be milk-borne, it seems only right that the milk-consuming public should get an article which is pure. It is no argument to say that because certain obsolete methods of handling milk have obtained for generations, they ought, therefore, to continue. On the other hand, when they are shown to be wrong, it is quite clear that they should be forthwith abolished.

A great deal of attention has been devoted in recent years not only to the providing of a pure milk supply, but also to the breeding of cattle, and, as we know, immense improvement has been made in that direction. It is rather difficult to state what is looked upon as the average yield of all the different breeds of milking cows, but it is safe to say that the quantity ranges between 300 and 800 gallons, on the average, during the period of lactation. In many countries, however, it has been shown that by careful selection it is possible to increase the milk yield to an enormous extent, and, bearing in mind the figures which I have quoted, it is of interest to know that what might be described as the world's champion cow, has been authoritatively tested, and has shown the gigantic yield of 2,743 gallons, or an average daily yield of 7½ gallons. The name of this cow is worth remembering; it is Colantha 4ths Johanna, and the Dutch breed, to which this animal belongs, have carried off the bulk of the honours in milk yield, throughout the world for a good many years.

They are, however, as susceptible as other cattle to tuberculosis, and in one of the largest byres containing these animals which I have visited, at Näsbyholm, in the south of Sweden, I was told that the owner of this herd started in 1895 to apply the tuberculin test, and found that out of the first twenty-two, twenty-one of them reacted. Determined, however, to provide a tuberculosis-free herd and a tuberculosis-free milk, the owner steadily continued to apply the tuberculin test until he has at the present day the distinction which few can claim either in his own country of Sweden or in any other country, namely, that his cattle are quite free from this insidious disease. Nearly all the milk of this particular herd is sold in Malmö; it is retailed in bottles at about 2d. per pint, and is in great demand there.

With regard to other countries, it may be said that there are many efforts being put forth to realise the ideal of pure milk, and to those who were privileged to be present at the International Dairy Conference held at the Hague in the autumn of last year, it must have been evident that the enthusiastic study which the various milk problems received, not only from the scientific men who were present, but from practical farmers also, meant much progress in the dairy industry in the various countries to which they belonged.

It will be of interest to quote one or two of the findings of this conference, as indicating the trend of opinion on these matters. Thus it is recorded that the Congress was of the opinion that the milk destined for consumption in its raw state, and especially for infants' food, must be supplied from healthy and well-fed cows which have been milked dry, further that it be well cooled after milking, and be of normal composition. The Congress was also of opinion that authorities should endeavour to eradicate tuberculosis, and for this purpose to institute veterinary supervision of cattle, as well as hygienic supervision of the cow-houses, and medical supervision of the persons charged with the milking, and with the treatment of the milk at the farms.

In how far these opinions, which carry such weight with them, are likely to have an influence on the future of dairying in this country, it is, at the moment, very difficult to say.

The hygienic conditions under which some of the byres in the United Kingdom are conducted, are repulsive in the highest degree, and, in many cases, the most absolute disregard is paid to the primary conditions of cleanliness.

Milk is the essential food of a large portion of the nation, and it has been estimated that there are forty-two gallons per head per annum consumed in one form or another. Any hidden dangers, therefore, which may lurk in it should be controlled by legal enactment. In some countries, such as Holland, there is complete control, and the milk is looked upon as being a possible vehicle in the carrying of disease, and it is treated, therefore, by Pasteurisation, and in some cases by sterilisation, in order to obviate any danger. The Dutch practice is of a very interesting nature, and more especially can this be seen to advantage at a large dairy institution, run on co-operative lines, which

exists at the Hague. The dairy supply of this institution is derived from 31 cowkeepers, who are also shareholders, and amounts to from 3,100 to 3,300 gallons per day. The main purpose of the dairy is the distribution of milk, and that is accomplished in a manner which is altogether admirable, not only by means of small hand-carts, but also by larger vehicles, but in any case it is always under control.

There is, of course, a considerable difference between the two aspects which characterise the milk trade in this country, namely, milk selling and milk producing, and in modern practice the two busineses are kept entirely separate. In the Hague, as we have seen, this method has been abolished, and the farmers sell their milk themselves direct from their own depôts The advantages of such a system lie in the absolute control which it gives of the sources of supply, as it is quite obvious that veterinary inspection can be methodically carried out in the byres belonging to such an organisation as I have indicated, and it pays to retain the services of a bacteriologist and chemists, in order to test with accuracy whether the milk is pure or not.

The disastrous effect which an impure milk supply may have cannot be too greatly commented upon. In so far as the food of children is concerned, the records of various institutions which have for their object the reduction of infantile mortality by means of a pure milk supply, show an encouraging state of affairs in the saving of lives. Unfortunately it is difficult in the United Kingdom to eliminate from the general statistics of infantile mortality what may be the percentage of deaths which are due to poisoned milk. It is notorious, however, that for fifty years in England and Wales our vital statistics show on the average the large total varying from 154 per 1,000 births to 139 per 1,000. In Scotland, during the last fifty years the numbers per 1,000 have stood at about 120.

I have said that it is a difficult matter to prove conclusively that such milk institutions as have been established in this country for the supplying of milk, either in the raw state or in a modified form, have successfully saved the lives of many children. There are many difficulties in the way of making such a statement, but we have the clear testimony of the Hon. Nathan Straus, in connection with the Infant Asylum at Randall's Island, New York, where, after a great deal of effort, he was allowed to supply the whole of the milk consumed in an institution devoted to the care of the waifs picked up in the streets of New York. He found the death-rate at 44·36 per cent. in 1897, and offered then to supply the milk to the institution, but his offer was declined. In 1898 he had his offer accepted, and the following statistics show the result of his introduction of clean milk:—In 1897 the death-rate per cent. out of 1,181 children was 44·36; in 1898, the year in which Mr. Straus was allowed to install a Pasteurising plant and supply milk free, the death-rate fell to 19·80 per cent., the number of children treated being 1,284. In 1903, the death-rate was still lower, namely, 18·63 per cent. Such a gigantic saving of life is surely much to be desired.

In the town of Rochester, again in New York, Dr. George Goler has carried on a splendid work, with the result that it has been proved beyond doubt that thousands of lives can annually be saved by rendering the milk supply pure. Briefly stated, his efforts have resulted in reducing the mortality amongst children under five years from 7,451 for the ten years ending in 1896 to 4,965 for the ten years ending in 1906. This shows a saving of 2,486 lives, among which were 1,554, or 62·5 per cent. of children under one year old. It is well to mention the latter fact as, during the period of life included in one year, milk necessarily forms the most important element in the food of children.

Such facts as we have alluded to are now beyond any kind of dispute, and it comes to this, that dairy farmers must either of their own free will or by the force of law be compelled to provide milk which will stand examination for cleanliness, and also be free from disease germs. This will, of course, involve a very considerable alteration in the practice which has obtained in dairies up till now.

The ideal system in the handling of milk is that it should be produced under perfectly hygienic conditions, where the byres are free from dust, and where the milk can be cooled to a very low temperature immediately after being drawn from the cows. The ideal, however, is next to impossible in practice, as the bulk of the milk consumed in our large towns is necessarily produced at long distances from these towns. The conclusion, therefore, which the International Dairy Congress arrived at, and which I have already stated, namely, that milk should be eooled immediately after milking, is not possible in ordinary dairy practice. What, then, is the next best thing to do? There is only one possible way by which

milk can be rendered innocuous, and that is by the application of heat, and this principle is being recognised to a greater extent year by year, and must ultimately become universal.

It is a long way back to the origin of the germ theory, so far back indeed as 1675, when Antony van Leeuwenhoek, a poor Dutchman, a polisher of lenses, discovered minute organisms in rain water and in vegetable and animal infusions. Since that time there has been a steady progress in the investigation of these mysterious organisms, which are only visible to the eye by means of powerful microscopes. It was left, however, till quite within our own day to discover that milk forms a most perfect host for a great variety of virulent disease germs, and we are indebted, as all the world knows, to Pasteur for having enunciated the law that heat will altogether destroy these germs. We might say, however, that while there are many germs which find a lodgement in milk they are not necessarily all of a disease-producing or pathogenic character. Many of them are quite benign, the principle being, of course, lactic acid. The presence of lactic acid or "souring" is due to the breaking up of the milk sugar, and this constitutes $4\frac{1}{2}$ to 5 per cent. of the milk. It may, therefore, be argued that if we apply heat as has been suggested, we shall also destroy the lactic acid bacteria, and this would be a danger in itself, inasmuch as they act as sentinels in the milk. Their presence in fresh milk serves to warn the consumer that a period has been reached in the age of the milk at which it may be described as unwholesome. It is quite easy, however, to overcome this objection, as lactic acid bacteria can be isolated, and after Pasteurisation of the milk some of these can be added to the milk again, so that they will be the only bacterial vegetation present.

This involves, however, a refinement of dairy practice which can only be attained through the education of those who practice dairying, and it is in this respect that the future practice will differ very much from the past, in consequence of the admirable training which is now available at the various dairy institutes and agricultural colleges throughout the country in the theory and practice of dairying. The hundreds of students who are being turned out year by year carry with them exact knowledge as to the principles which govern the handling of milk in a hygienic way, and when they come to put these principles into practice we can only hope that the effect will be to increase enormously the supply of hygienically pure milk.

It may be worth while at this point just to mention briefly what the composition of milk is, and how it comes to pass that a knowledge of its composition is so essential. Cows' milk, which is the commodity that we are concerned with here, consists of water, fats, albumenoids, or substances containing nitrogen, sugar and ash, each one of these being present in pretty constant proportions. The percentages may be given as follows :—

Water	87·25	per cent.
Fat	3·50	,,
Casein	3·50	,,
Albumen	0·50	,,
Sugar	4·50	,,
Ash	0·75	,,

It is obvious that, in dealing with a substance like this, which is very complex in its character, there should be some previous knowledge as to the results which may be obtained by any particular procedure, and at this point it is well to state that the complex nature of milk is far from being completely understood. As a consequence we hear various opinions stated, even amongst scientific observers. It is, for example, asserted that complete sterilisation means the destruction of the food properties which milk contains. It has also been stated that the digestive enzymes are completely destroyed by sterilisation. If that is so, then it is surely possible to replace these digestive enzymes so as to again restore the digestive properties. Whether that may be attainable or not, however, has not yet been determined, but this we do know, that we must look upon milk, as indeed upon all other dairy products, as belonging to a class of foods in which there are no waste substances so far as the human economy is concerned, and each component part, separately or in combination, is totally consumed within the system. It is this fact that renders the necessity for absolute purity a very real one, and hence we come to the conclusion that it is not only necessary for the modern dairyman to understand the composition of milk, but also to understand its possible dangers, and whatever methods may be available for averting these.

We are indebted to the United States of America for the records of much laborious investigation with regard to milk, and it is a pleasing feature of the administration of agricultural matters in that country that large subsidies are given annually to various agri-

cultural institutes and experimental stations, whose efforts are, to a large extent, devoted to the examination of milk and its products, and the investigation of every possible problem which their manipulation may involve. Considering, therefore, that so much is being done elsewhere, it seems a reasonable plea to put forward in our own country, namely, that there should be State endowment of research into the milk question.

At the present day there are a certain number of advanced milk dealers who fully appreciate the value of modern methods, but, on the other hand, the great majority of dairy farmers object to what they consider unnecessary interference with their business, and they cannot realise the enormous dangers which are associated with the milk supply. There is a small minority who deliberately attempt to derive profit out of the milk supply by means of adulteration. Such a class happily is small, but their relative strength may be gauged from the fact that the milk of London is reported to be adulterated to the extent of 12·8 per cent., and the butter to 10 per cent. There is, of course, no other way of dealing with these people except by the rigid enforcement of laws against adulteration, and the imposition of such punishments as will retard others from following these particular methods.

The dairyman who would conduct his business so as to satisfy the requirements of modern science must Pasteurise all his milk, and as this is a process which is capable of being misunderstood, I think that the best way to arrive at a knowledge of the matter will be simply to describe what takes place in an up-to-date dairy.

If we assume that milk has to be delivered in a town where there are either very few or no cow-sheds, then we must proceed to the farm where the milk is produced. Here much trouble may be avoided by the proper attention to hygienic conditions, as prevention is better than cure in this matter perhaps more than in most others. The milk should be drawn from the cow by attendants who are cleanly in their habits, and the udders should be cleansed before milking. In some cases, even brushing of the animals' hides is resorted to, and in the Swedish dairy to which we referred at the beginning, which is tuberculosis-free, it is necessary for anyone going into the dairy to render his boots sterile by dipping them into a solution of antiseptic, before proceeding inside. When the milk is drawn, the first should, of course, be either entirely rejected, or should be dealt with separately, as it has been shown that the first drawn milk is teeming with bacteria. The milk, on the other hand, in the interior of the udder is perfectly sterile, and this even may be the case, we admit, when an animal is suffering from generalised tuberculosis. If the milk is drawn under the conditions suggested, and cooled at once by means of refrigerating plant, then there is little liability of its becoming dangerous within a reasonable period. The difficulty, however, is that in our large cities the milk supply has to be obtained from a long distance, and this involves keeping the milk cool during transit. That also is quite attainable by means of refrigerated waggons, but the difficulty then arises as to the cost of transport under such condition. The railway companies naturally object to any method of transport which will increase their expenditure, and if such waggons were cooled by either ice or travelling refrigerating machines, there is no doubt that a considerable addition would be made to the cost of carriage. It is, therefore, evident that in a great number of cases when milk arrives at a town's dairy it arrives in a condition when it is charged with bacteria, which have been taken up from the air, dust, or general surroundings, during the journey. I have already emphasized the fact that it does not necessarily follow that these bacteria are injurious. On the other hand it is quite possible that they may be harmful, as the methods of ascertaining the presence of disease in cows are not of a very perfect character, and, as general inspection of country byres is not complete, then we are bound to assume that the milk as it arrives in a town is contaminated. The mere fact that there is a possibility of tuberculosis of the udder existing is in itself a hidden danger which must be dealt with. The number of cows subject to tuberculosis of the udder has been variously stated, but it is clear that no absolute figure can be arrived at in such a matter, except through laborious enquiry. Taking, however, the evidence derivable from our abattoirs it may be stated that the number is reckoned at anything between one and two per cent. If there should be one animal in a herd suffering from tuberculosis of the udder, then it is quite plain that the whole supply from such a source constitutes a danger. Hence, on arrival in a town, it must be dealt with so as to destroy these and any other germs, such as the organisms of measles, diphtheria, fever and others which

may be milk-borne, and to which milk presents a ready means of transmission and propagation.

In a modern dairy the milk is received, and is then run through a strainer, of which there are many designs in existence. From the strainer the milk falls into a receiving tank, where the total bulk is all mixed together up to the capacity of the tank. From this tank it falls into the receiver of a Pasteuriser, in which it is heated to a temperature of 176° Fahr., which is a temperature beyond the thermal death point of pathogenic germs. It is necessary, however, to observe that this heating must be done quickly, otherwise a certain taste is imparted to the milk which is objectionable. The taste may be due to the caramelisation of the milk-sugar, and to many palates this fact may render the milk objectionable. Pasteurisers, therefore, are made so that the milk flows in at the bottom, and is elevated by means of rotating arms, which cause the milk to run over a heated paraboloid surface; it is then discharged at the top, and at once is passed over a cooler. In modern dairy practice it has been found desirable to take advantage of the cooling effect of water as a primary cooling agent, it being quite obvious that where water is available it is necessarily the cheapest cooling medium. It is, therefore, wise to provide what is termed a "primary cooler," in which water is circulated, and over which the milk flows after being discharged from the Pasteuriser. If the water passing through the cooler is at a temperature of 52° Fahr., which is the average temperature of well water in the United Kingdom, then it is found that by using certain forms of cooler, the milk from the Pasteuriser can be cooled to within 4° Fahr. of the water temperature, that is to say 56° Fahr. This end is best attained by means of a conical cooler, as the milk falls upon the upper flutings in a certain volume, and as it reaches the bottom it broadens, and thus a finer film is formed, which is more easily cooled. Passing from the primary cooler, we then have a secondary cooler, which is attached to the refrigerating machine. The refrigerating machine is used to cool an unfreezable brine, which is circulated through the secondary cooler at a temperature approaching freezing point. The same effect is obtained as with the water, namely, that the milk flowing from the primary cooler is at once cooled to within 4° Fahr. of the circulating brine. Thus, if we have brine circulating at a temperature of 36° Fahr., we will get a milk cooled down to 45° Fahr. At such a degree milk is entirely inert, that is to say, if there are any species of germs present they will not develop, and if the milk can be maintained at or about that temperature there can be no doubt that it will be in a pure condition, and practically germ free. Briefly speaking, that is the description of the Pasteurising process. As we see it is simple enough, and is capable of large variation; thus, it may be worth while to interpose what is described as a "regenerative heater" between the Pasteuriser and the cooler, by which the excess of heat in the Pasteurised milk is used to heat the incoming fresh milk up to a certain degree and thus save fuel. I have not found, however, that this particular appliance has been received with much favour. It certainly possesses advantages which are incontestable, but it adds, to the plant necessary in a dairy, and that is always an objection.

The principal plant, as we see, in connection with the production of germ-free milk, consists of steam and motive power, a Pasteuriser, water supply for cooling the primary cooler, and a refrigerating machine for cooling the secondary cooler.

Modern dairying, however, has gone beyond the mere idea of Pasteurising, and there is a considerable body of opinion which inclines to think that Pasteurising and the selling of milk in the open state is not sufficient. Pasteurisation and the distribution of the milk in bottles may be sufficient, and as a matter of fact is very considerably practised, but there are many who think that the sterilisation or the heating of milk in bottles, to a very high temperature, say 212° Fahr., is absolutely necessary to obtain immunity from all possible disease. I am not inclined to support that view, and I should be disposed to say that the lower the degree at which effective destruction of disease organisms can take place in milk, the better will it be for the ultimate consumer. Again, in all our milk depôts which have been started for the supply of germ-free milk with a view to the reduction of infantile mortality, it has been customary to adapt the milk to the various ages of the children supplied. That seems only a reasonable proposition when it is considered that cows' milk is not the natural food of children at all, and that in its principal characteristics it differs entirely from human milk. It is, therefore, necessary to consider the problem of how to approximate as nearly as possible to the

natural food which children ought to have. This is a matter, however, which is yet waiting for investigation. It has been shown that benefits have been scattered amongst the poorer population by the supply of milk from such depôts. On the other hand, we have also to consider that none of these depôts have been a commercial success. They have indeed all been run at a considerable loss to the community, and there are many ratepayers who consider that they are entitled to protest against the use of their money in indiscriminate charity, under the administration of the local medical officer of health. The other point of view is, of course, that the burden on the rates is very trifling in connection with these institutions, and if they became universal, it would be of enormous national advantage, and hundreds of thousands of infant lives which are now deliberately wasted, would be saved to the nation.

There are other phases of modern dairying in which the same principle of the application of heat becomes the prime factor, as it is in the handling of fresh milk. In butter-making, it is necessary to utilise not only heat in the destruction of free and dangerous bacteria, but it is necessary also to eliminate and isolate such bacteria as go to assist in healthy fermentation. It has been shown that the best butter is obtainable from cream which has been Pasteurised to a high temperature, and in which some of the germs have been destroyed.

In a butter factory, the appliances are somewhat more elaborate than in an ordinary towns' dairy, but the principal rule is the same. Thus the milk is received and passed through a strainer, and is all mixed together in a general containing tank, after which it is Pasteurised, and is then partially cooled to a degree at which effective separation of the milk and cream take place. The whole milk is then allowed to flow into a centrifugal separator, and is divided up into its main constituent parts of cream and separated milk. The cream is again, in the most modern places, Pasteurised, and is cooled down to a temperature of between 50° and 60° Fahr. At that temperature a pure culture of lactic bacteria is added and the fermentation of the cream takes place, so that in a matter of about one day's duration the cream is sufficiently fermented to be at once churned, and made into butter. The fermenting process, it is curious to relate, is accompanied by an increase in temperature of the cream of about 10°, and it has been proved that the best aggregation of the fat globules takes place when the cream has been reduced to something over 50° Fahr. before it is placed in the churn. The churning causes the fat globules to go together, and butter is the result.

I do not describe in detail the process of butter-making here; it would take too long to do that, but enough has been said to show that in a butter factory the principal factors are heat and cold. The heat is derived from the ordinary steam supply of a factory, and is used to destroy germs, and the cold may be derived from a refrigerating machine, and is used to reduce the temperature of the cream in a mechanical way so as to arrive at the best granular appearance of the butter which is the main article of produce.

There are a large number of accessory appliances in a modern creamery, and instead of these being reduced in number, many improvements have been introduced of late years, which have their merits, and some of them, perhaps demerits. In any case the number of appliances which are considered necessary to a modern creamery is considerable, as may be inferred from the fact that a creamery to deal with the milk from 500 cows per day, with a view to making butter therefrom, would cost for mechanical appliances alone, somewhere about £1,000.

There are many other developments of modern dairying, such as the production of special milk as Kumiss, carbonated milk, which may yet have a future before it when the effect of the carbonic acid on the lactic fermentation has been fully investigated. There is also, as is well known, condensed milk, which is really not milk at all, but a manufactured article which has as its basis cows' milk. It is an astonishing thing to find that there are the equivalent of 250,000,000 gallons, or the product of 500,000 cows, imported annually into this country under the name of condensed milk, and that this business is carried on without any control whatever as to the sources of supply. There is also a lot of milk being brought into this country in the frozen condition, and even during recent months whole milk in the ordinary way, but so far without any attempt at examination of the sources of supply. This seems to be an anomalous state of affairs, when we consider that there is so much talk of rigid control of dairying in this country, and when matters have reached such a stage that the Minister responsible for the control of the milk supply, has announced a very drastic measure in

connection with that business. Doubtless there will be some examination of milk at the port of landing, but that, under the circumstances, seems hardly sufficient. There seems every likelihood that the cowsheds' and milk-shops' orders will be revised. The fact that tuberculosis is capable of being transmitted through milk will also be recognised, and various proceedings will be legalised, such as sampling the milk at railway stations, and the visiting of farms in the country, and the extension of wide powers to the county councils in connection with the control of dairies. Legal control is then the only remedy for the dangers to which milk is subject, and we find that in many countries this stage has been arrived at long ago. Take, for example, Denmark, in which it is compulsory to Pasteurise milk; then again we have Holland where a splendid system of control is in operation, not only in connection with the milk supply, but in connection with the butter produce. There can indeed be nothing finer in the way of control stations than those admirable institutions which exist at various towns throughout the Netherlands, and exercise the functions of control stations so as to ensure that butter produced in the dairies of Holland will reach a certain standard, and be free from adulteration. Such institutions exist at eight different centres in that small country, and are equipped in a manner which reflects the greatest possible credit upon the Dutch Government. Unfortunately there is so far, no compulsory reference to these institutions, but they have so well warranted their establishment that there seems every likelihood that they will be soon placed in a position to control the total dairying and butter industry of the country.

In butter control, indeed, there are many lessons to be learned from other countries. In this country we are unhappily buyers of foreign butter to an enormous extent, and we have made it pretty clear that what is wanted here is butter which is beyond suspicion. Hence we have compelled butter-producing countries to institute such systems of inspection and methods of examination as will ensure our getting what we want. The fact, however, that from time to time we get prosecutions showing that butter which we import is impure, demonstrates the fact that no system which can be adopted anywhere can be perfect. It would be, however, of immense advantage if control stations were instituted in the United Kingdom, and if the dairying industry generally was treated in a more handsome way than it is at present. There ought to be some system of reference to such institutions in connection with dairy produce, and it would pay the country to increase the subsidies which are at present given to a few agricultural colleges and to some county councils, in order to provide competent instructors to proceed from one centre to another demonstrating what is the best practice in connection wfth dairying.

As I have already shown, the whole industry is in course of being revolutionised, and what is likely to occur when the threatened legislation is brought into force it is difficult to foresee. It is likely that there will be a considerable elimination of existing members of the trade, not only in London but elsewhere, and the small distributor will be put out of the business. That may seem a disadvantage and a cruel proceeding, but it is impossible to conceive of any general laws which can be inaugurated without hurting someone. Let us hope, however, that whatever may be the effect of the contemplated laws, there will be general co-operation amongst the members of the dairy industry throughout the country to, bring their business, as far as possible, into line with modern scientific thought.

DISCUSSION.

The CHAIRMAN (Mr. James Cantlie) in opening the discussion, said the author had suggested in the course of his paper that a lecturer should be sent round the country for the purpose of imparting knowledge that was very much required on the subject. He ventured to suggest that Mr. Douglas should be sent round as the milk apostle all over England, because he was sure in that manner the health of England would be improved. The author, however, had not exhausted in his interesting paper all the points connected with the subject. For instance milk should be sent out with instructions as to *when* it was to be drunk. From a medical point of view it was necessary to take milk at specific times, just in the same manner as medicine and foods of various kinds were taken. To drink milk with meat or fish was against all physiological reasoning. The old Jewish law said that milk should not be drunk until two hours after the flesh of goats had been eaten, and that law held good just as well in the present day as in the times of Moses. Those who ate a milk pudding after their chop in the middle of the day were transgressing the law of Moses; and it was impossible to do such things and hope to escape indigestion. Only milk should be drunk by children up to the age of 7 months old, and up till that age it was impossible for a child to

take infant's food with impunity and not suffer from it. The manufacturers of patent food admitted that privately, but did not put it on the labels, because if they did they were afraid they would never sell any patent infants' food at all. Until a child was 7 months old it has not the organs sufficiently developed to justify milk being given; the pancreas which was the chief milk digester, not beginning to work until a child was 7 months old. It was like giving an infant under 7 months of age rank poison to give it infants' food. He was born in the North of Scotland, where the quantity of milk the natives drank with their meals was simply gigantic, amounting to 2, 3 or 4 pints a meal. The milk, however, was skim milk, because it would be impossible for anybody to drink that quantity of cream milk without upsetting the liver. He had been in China, where milk was never touched by any individual, in fact, milk was drunk by a very small section of the human race. In China, the child fed on the mother's milk, and when the mother had no more milk a foster-mother was requisitioned, or the water in which rice had been boiled was used, that containing a large amount of nourishment, and it took the place of milk. Milk, however, was not an essential food for the human race, although it was in this country, because there was no substitute for it, and therefore it should be obtained pure. With regard to the question of milk carrying phthisis, there was more of the disease in China than in this country, and it could not be attributed to the milk because none was used. There were other causes of phthisis. Professor Koch had said that he did not believe tubercle from cattle was conveyed by milk to man. That had been doubted by almost everyone except Koch, and even Koch did not absolutely prove it scientifically; he simply said it was his opinion. Recent investigations had tended to show that in all probability it was conveyed from animals to man. There were a good many diseases conveyed by milk other than tuberculosis, and hence the absolute necessity for milk being pure. A number of pictures had been shown by the author of dairies in different parts of the world. England was not behind the rest of the world in that respect, but in one matter it was, namely, in co-operation. He knew a village in Hertfordshire where three dairy farmers lived and worked, who each separately sent their milk to market, the British spirit of independence being so strong that it would not allow them to co-operate, although if that plan was adopted great savings would be made. Probably poverty would eventually drive them to adopt it, and it would be a good thing for the farming industry when that condition of affairs came about. A good deal was heard at the present time about tied public-houses, but there were also tied milk farms. Beer was a luxury, but milk was a necessity, and therefore a tied farm in the country was a danger. In the village in Hertfordshire to which he had referred, few of the children could get milk, because the farmers were under contract to send it to London. The Milk Trust was the most dangerous of all, because it struck at the very vitals of the nation; but the means by which it could be overcome it was difficult to foresee.

Miss Everest asked what precautions were taken to ensure the proper cleansing and sterilising of the pipes of the Pasteurising and cooling plants.

Mr. T. W. Edmonds thought the milk in London was not adulturated by legitimate dairymen, but by the small pettifogging people who walked about the streets with a hand-cart, or who sold milk in chandler's shops. The usual dairyman was a straightforward man who tried to conduct his business on scientific principles and was willing to adopt any reasonable suggestions. He knew of a case in which a child under seven months of age was not allowed by a doctor to have humanised milk. With regard to the question of tied farms, most of them supplied the dairymen of London under contract, but they were not compelled to sell the whole of their produce. The children in the country were allowed to have the milk if the farmer would supply them with it, it resting entirely with the farmer and not the dairyman in London. The London dairyman wanted as much milk as he could obtain, and if farmers made a contract for a certain quantity of milk they must supply it, or within a certain reasonable limit. In reply to a question which had been asked, he thought most Pasteurisers were sterilised by passing hot water and soda through them, after which they were taken to pieces and carefully cleaned with a brush.

Miss Webster enquired whether the Pasteurisation of milk by means of heat caused it to have the same taste as Devonshire milk and butter, or whether it had the same flavour as ordinary milk, cream and butter. She thought it would also be of interest if the author would state whether the imposition of so many restrictions upon dairy farmers would not have the effect of preventing them keeping cows even in the limited number they did at the present time.

Mr. John L. Escudier, in dealing with the question of adulteration, thought there was often a difference between the morning and the afternoon milk, which was regulated by the length of time the cows went between one milking time and another. For instance, the morning milk might be above standard and the afternoon milk below standard. Summonses had been issued against dairy farmers for adulterating the milk, but in many cases there had been no adulteration at all, the fact being that the cow had yielded milk below the legal standard. He thought a great deal more should be done by the local authorities, especially in the provinces, in dealing with the question of the purity of milk. The Cowsheds' and Milk Shops' Order extended to the whole of England, but it seemed as if it were only put in force in the district of London by the London County Council. In the Midlands the local authorities did not seem to know they had any power, and the cow-sheds were in a most terrible condition. He

thought before additional powers were sought for, the local authorities throughout the country should put in force the powers they already possessed.

Mr. DUNBAR KELLY enquired whether the author suggested that a cow which had tuberculosis of the lungs could, through its milk, give tuberculosis to a human being. It had not even been proved yet that a cow, with tuberculosis of the udder, could affect a human being, Koch disputing that point. Personally, he would not be willing to drink the milk of a cow which he knew had tuberculosis of the udder, he being of the opinion that such animals should be destroyed, and the owner compensated out of public funds, but he would be willing to drink milk from a cow which had tuberculosis of the lungs. He thought the author had exaggerated the beneficial effects of cooling, when he said it would destroy infectious germs. As a practical dairy farmer, he believed the effect of cooling was to preserve milk in a sound condition for a longer period than if it were uncooled. He believed more than half the milk produced on the farms of the country was cooled at the present time, and that the proportion was increasing year by year. A good deal of harm, caused by milk, was not due to any action on the part of the dairy farmer who, next to the brewer, was the individual most held up to public execration at the present time. There was a great amount of contamination of milk after it left the farmer's hands. At a recent public meeting he stated that, at a station not very many miles out of London, to his own personal knowledge, fifteen or twenty churns of milk, day after day, stood for hours outside the urinal windows. Such gross neglect of their duty, on the part of the railway company, could not be beneficial to the milk. He supplied a large London dairy company with milk, from whom at one time he received continual complaints. The company was supposed under their agreement to cleanse their churns before returning them to him, a thing all dairy companies should do, it being necessary to cleanse churns as soon as milk was emptied from them. He had the opportunity one day of showing the managing director of the company, when he happened to be on his farm, the state in which the churns were returned to him. Scraping his finger down the inside of one of the tins, his nail was filled with filth ; and after that he received no further complaints from the company as to the condition of his milk. The public were also not blameless, because the receptacles they used for the milk were often not clean ; in fact, a large proportion of the harm, especially to young children, was caused by the careless treatment of the milk after it was in the consumers' hands. A campaign was going on in the Press against the dairy farmer, particularly on the part of two rather notorious halfpenny daily papers, and the dairy farmer was supposed to be the originator of all the evils from which the youthful population of the country suffered ; but, as a practical dairy farmer of many years standing, he held that the consumer was as much, if not more, to blame for any harm caused by the consumption of milk as the producer. Personally he did not care what reasonable regulations the Government put upon the production of milk, so long as they were imposed all round. It was not fair that regulations should be imposed on the British farmer, while the foreign producer was allowed to send his articles in without inspection, but under the same regulations he guaranteed that the British farmer would hold his own against the world. From what was known of the character of the Russian peasant, it would not lead anyone to suppose that Siberian butter was likely to be perfectly pure ; on the contrary it was likely to be impure and filthy. There could be no doubt that the imposition of additional regulations would have the effect of making it more expensive to produce milk, and the public would have to pay for it.

Mr. T. W. EDMONDS stated that Professor Lloyd recently made the remark at a public meeting that samples of milk were taken in a street in London were diphtheria had resulted, it was supposed from the drinking of milk ; and upon examination it was found that the milk was very much contaminated with manure. That was due to the fact that the people when they bought the milk placed it in an uncovered vessel on a sideboard, and that the dust, which was mainly composed of horse manure, was blown through the windows and contaminated the milk. The author had also stated that it was necessary for Pasteurisation to heat the milk to 176°. Personally he had always thought that 150° to 170° was sufficient.

Mr. ROBERT COOPER thought that on the question of the primary handling of milk at the farm the author did not lay sufficient stress upon the necessity for straining and cooling the milk before it was sent on a railway journey. So long as cow nature and human nature was what it was, it was absolutely necessary to strain milk immediately it was obtained. At certain seasons of the year, milk arriving in London and other large towns was a great deal dirtier than at other seasons, but the necessity for straining on the farm existed all the year round. The author had stated that it was not possible as a rule to cool milk on a farm ; but in all milk contracts there was a clause to the effect that the milk must be cooled to a temperature within two or three degrees of the temperature of the water obtainable on the farm. All milk which it was intended to send by rail should be cooled before it left the farm within two or three degrees of the water temperature. The author had shown photographs of primary and secondary coolers. Personally he was of the opinion that it was a mistake to expose milk twice to the atmosphere in being cooled, and that there was no necessity for it. In a great number of plants which he had installed in London and the country, the cooler was of a combined pattern, the upper portion having water circulated in it, and the lower portion cold brine. He understood the author to say that the interchanger heater had

not been received favourably by the dairy companies, but his own experience had been the opposite. In 90 per cent. of the plants he had installed the interchanger heater had been a feature, and he had no difficulty in persuading the average intelligent proprietor of a modern medium-sized dairy, or the directors of a large concern, that an interchanger heater paid for itself, seeing that it removed about 15 degrees from the temperature of the milk delivered on the cooler, where it was not required, and transferred it to the Pasteurising part where it was required. With regard to the necessity of straining milk on a farm, he knew that in a large modern dairy plant it had been found beneficial to instal a separator, not for the separation of the butter fat from the milk, but for the extraction of dirt in the milk. The author would bear him out in the statement that the inspection of the interior of a centrifugal separator which had been used for the separation of the butter fat or the extraction of dirt was not a very pleasant experience, the bowl being filled up with more or less semi-liquid filth extracted from the milk. The question of the sterilisation of milk pipes had been mentioned, and he had noticed in one or two of the photographs shown that there were bends in the piping. In his opinion there should be no bends whatever; all the pipes should be in straight lengths, capable of being disjointed, and at the junction of the pipes there should be a cleansing plug or aperture through which a brush could be pushed. On taking down a pipe with a bend in it in a certain dairy, he discovered that in the neighbourhood of the bend there was a small tea-cup full of filth, so that the Pasteurised milk was being delivered to the cooler over the filth, this largely undoing the effects of the previous treatment.

Mr. S. H. Herkomer enquired whether it was advisable to put a wad of cotton wool into the bottom of the pail when milking was being done. He had heard that was a good way of straining the milk.

Mr. Douglas, in reply, said the subject was so large that a series of papers were necessary to deal with it, and therefore some of the points raised in the discussion had not had the attention paid to them in the paper, which they might have had. For instance, the mechanical fittings in a dairy required an immense amount of study in detail. He quite agreed with Mr. Cooper that no sensible man would put any bends in the pipes without having inspection taps. The Pasteurising plant was usually cleansed by means of steam, and if there was any deposit of the albuminous compounds or casein on the pipes it was easily removed by steam or a solution of soda. He was quite unable to say whether the adulteration which existed in London was amongst the very small or large dairymen, and did not think the subject came within the purview of his paper. Humanised milk had certain merits, and if the child to whom it was given was healthy it was beneficial; but he thought it was always necessary in such matters to take advice of a physician. He also thought the question of tied farms did not come within the purview of the paper, but it was unfortunately an evil which existed not far from London, and he did not know that any means could be devised by which the poor farmer could resist having to accept a contract which involved the taking of the whole of his supply. One hundred and seventy-six degrees was looked upon as being the effective temperature for Pasteurisation, because it was beyond the thermal death point of pathogenic bacteria. He was aware that a lower temperature of, say, 148°, if continued for 20 minutes, would give the same result, but modern practice would not allow of such a length of time being taken to Pasteurise milk. It must be done quickly, and the only way in which that was possible was the way he had described in the paper. The Pasteurisation was done instantly; from the moment the milk left the receiving tank till it was cooled down to 38° only a short time elapsed. That answered the question with regard to the two coolers, the primary and the secondary, the passage being so rapid that he did not think it affected the milk at all. He had not noticed any increase in the bacterial vegetation in consequence, but he was open to conviction in the matter by a practical demonstration. He had asked a good many times if the mantles which were used in Sweden and Germany were really effective, and had always received the unsatisfactory answer that it was quite obvious they must do good, but he had never been favoured with any facts; and so far as the paper was concerned he had endeavoured to deal with facts only and not opinions. He quite agreed with a good deal Mr. Kelly had said with regard to the transmission of tuberculosis by milk, but he disagreed with him with regard to the question of the suspension of the tuberculosis. He thought it was quite possible that generalised tuberculosis or tuberculosis of the lungs might not be transmitted, but he thought they were bound to assume in the majority of cases that it would be transmitted. Although Dr. Schroeder had demonstrated that germ-free milk, so far as the tubercle bacillus was concerned, could be obtained from a cow with generalised tuberculosis, he thought that where one cow like that was found, ten with localised tuberculosis in which the germs would appear in the milk could be discovered. The evidence he possessed led him to believe that the milk of a cow with tuberculosis of the lungs had been proved to contain the germs of tuberculosis, and he had come to the conclusion that the tuberculosis was transmissible. He did not intend to say that cooling destroyed infectious germs; the speaker misunderstood him on that point. Cooling was part of the process of maintaining the Pasteurised milk in an inert condition. Once the milk was in an inert condition, the cooling permitted the milk to be maintained in that condition for a reasonable length of time. If the milk was then taken into a warm atmosphere, which was

charged with disease germs, the milk would get contaminated again. Milk was one of the best, if not the best, hosts for germs that could be found. A good deal of trouble was caused in households by the fact that people did not understand that milk should be put in clean vessels, and the distribution of milk in bottles, which had developed so much of late years, was a step in the right direction. He had seen an immense amount of bacterial growths taken out of milk, as Mr. Cooper had remarked, by means of special adaptations of a separator, and there was no doubt also that mechanical straining was a very good thing. The majority of sensible farmers certainly strained their milk at the farm, because any injurious matter which got into it could only be removed in that manner. Fine material, such as dust, which gave rise to bacterial vegetation, could be removed by a separator, and he recommended its use for the purpose. For household purposes to prevent harm from the possible contamination of the milk supplied, he suggested it should be boiled and the vessel which contained it covered with canvas or muslin to keep out germs which might be likely to get in from the atmosphere. The sand filter was useful, but it was troublesome to work. Pasteurisation slightly altered the flavour of the milk.

The CHAIRMAN, in proposing a cordial vote of thanks to Mr. Douglas for his instructive and interesting paper, said that if milk was scalded, so that a thin skin collected on the top of it, the same effect was obtained as in Pasteurisation: and if the milk was kept cool no disease could result from its use. It was not a scientific remedy, but it had the advantage of being practical.

The vote of thanks having been carried unanimously, the meeting terminated.

TURKISH COTTON.

The growing of cotton in the Levant was first established on a large scale during the cotton famine, consequent upon the American civil war. When peace was proclaimed, and American cotton began once more to supply the markets of the world, this great staple product did not continue to find much favour among the planters of Asia Minor, for the reason that it was found more profitable to plant vines instead. As a result, the production of cotton in the Smyrna district has greatly fallen off; in 1906, not more than 32,000 bales, of 440 pounds each, being produced. According to the American Consul at Smyrna, two kinds of cotton are grown in that district, which differ in several essentials. There is what is known as native cotton, or cotton grown from native seed. The pod when ripe does not, like that of the American cotton, burst open and permit the cotton to be gathered without the husk, but sticks so closely to the pod that it has to be gathered together with the pod, which is removed by hand by women at the factories, in the interior, before shipment to Smyrna. Cotton grown from American seed produces a longer staple than the native plant, and, despite the fact that it sells at 5 per cent. higher than the native cotton, only about 10 per cent. of the whole crop is from American seed. The reason for this is that fresh seed has to be imported at least every two years, otherwise the plants soon deteriorate and produce no better cotton than do the native plants. After being gathered in the month of October, the cotton is almost all taken to the factories in the interior, near where it is grown, to be ginned before shipment to Smyrna. Aidin is the principal place where this is done, there being several large ginning plants employing steam-power, and using between them from 3,500 and 4,000 roller gins. After ginning, the cotton is pressed into bales, each containing about 440 pounds. Of the 32,000 bales of cotton produced in the Smyrna district, about 6,000 are used in a local yarn mill, which employs about 10,000 spindles. A weaving mill is now being established in the island of Mitylene, and it is expected that it will give an impetus to the cotton-growing there, only about 1,000 bales being produced annually on the island. The balance of the cotton is exported chiefly to Italy and Spain. Constantinople and Salonica, in both of which cities there are yarn mills, draw part of their supplies of raw cotton from Smyrna.

INTERNATIONAL ART CONGRESS.

The third International Congress for the Development of Drawing and Art Teaching will be held in London from August 3 to August 8, 1908. The first Congress was held at Paris during the Exhibition of 1900; and the second Congress at Berne in 1904. A permanent Fédération Internationale de l'Enseignement du Dessin forms a permanent Committee to ensure continuity of the work from congress to congress.

It appears that a mistaken assumption is current in some quarters that a movement, of which the Congress is an outcome, will tend to multiply pictorial artists. Mr. Keighley Snowden, Chairman of the Press Committee, writes that the Congress is concerned with the teaching of those practical arts which, abroad, associate the schools and workshops closely in a competition with British manufacturers. Drawing is taught, like writing, in almost all Continental schools. The main and very generous educational equipment of foreign art schools has to do with the application of art to Industries.

The British Committee of the International Art Congress base their appeal for public support largely upon the fact that this foreign activity, maintained with great intelligence, is found to threaten our commerce more shrewdly and more seriously than British manufacturers are, even now, aware or apt to imagine.

HOME INDUSTRIES.

Wheat Supplies.—The expectation that the past three months—December, January, February—would see a short supply of wheat, and prices correspondingly higher than those even of October, has not been borne out by the event. The experts were in agreement as to the shortage in the world's wheat crops, and they put the deficiency of supply at from 9,000,000 to 12,000,000 qrs., but they seem to have under-estimated the effect of the high-price level upon consumption, and in drawing out reserves from the "invisible supply." Instead of scarcity in recent months there has been over-abundance of supplies, with the result that prices have declined from 5s. to 10s., as compared with the highest prices of October. In the three months ended January, the consumption as gauged by weekly deliveries to customers averaged 180,000 qrs. per week less than in the corresponding months of 1906-7, and 300,000 qrs. less than in the same period of 1905-6. And if consumption has fallen short of expectation, supplies have largely exceeded it. In the first eight months of 1905 American exports reached 4,750,000 qrs., against 2,570,000 qrs. in the same period of 1907; and the Argentine exports have been on an unprecedented scale, the shipments since January reaching 3,858,000 qrs., against 2,231,000 qrs. last season. From other countries the shipments have been much as was expected, but on the whole in excess of estimates. Assuming the requirements of importing countries for the remainder of the crop year to be normal, some 26,000,000 qrs. will be wanted, towards which Argentina is expected to contribute 13,000,000 qrs., and it may be reasonably assumed that the other exporting countries will not have much difficulty in making good the balance. Assuming, again, average conditions during seeding, growing, and harvesting times this year, and the probability is that there will not be any very serious advance upon present quotations.

The Eight Hours Bill.—The Bill now before Parliament to limit the miners' hours of labour to eight is viewed with considerable misgiving by many who are not coal owners. The eight hours is to be from "bank to bank," that is to say anyone who works in a coal mine would have to be out of it again within eight hours of his descent. Colliery employees may be divided into two classes, the contractors and daymen. The contractors are usually paid by results and they employ other men to whom they pay daily wages. These men work about 54 hours per week less half an hour per day when the pit stops coal winding and the men get food. A considerable time is spent in getting from the shaft to the point of work and this, assuming the Bill became law as it stands, would have to come out of the eight hours, so that instead of working 54 hours a week as now the men would work nearer 44. The time would vary because the older the mine the greater the distance to be travelled to the point of work which recedes from the shaft as the coal is worked out. It would seem to follow (1) that the contractor would not be able to pay his men as much as he pays them now since his own earnings would be diminished owing to the decreased output, and (2) the men employed in the older mines would suffer more than those at work in the mines opened recently. And from the employers' point of view it is urged that the proposed limitations of hours would unfairly hit the older mines compared with those more recently opened up. Mine owners with large interests in new pits would, it is urged, be able to ruin the older collieries by winding longer hours at the recently developed collieries and so getting a much larger tonnage on the market at much less cost, whilst many collieries which under present conditions might be worked for years to come would have to close down since it would no longer pay to work them. Expert opinion remains much divided as to the wisdom, or otherwise, of a compulsory eight hours day for miners, and when it is remembered that the miners themselves are by no means agreed on the point it may be gathered that there is much to be said in favour of very full consideration before making an eight hours' day from bank to bank compulsory.

British Shipbuilding.—Lloyds' Statistical Tables for 1907 show the extent to which foreign nations still resort to British yards for their ships. Last year there were built in these yards 23 vessels for Germany, of an aggregate tonnage of 79,132 tons; 22 for Austria with a tonnage of 61,606; 15 for Holland with a tonnage of 31,443; 17 for Norway with a tonnage of 39,654; 20 for Denmark with a tonnage of 38,089; and 9 for the United States with a tonnage of 30,814. We also sold to foreign countries 235 vessels of a total tonnage of 282,058.

Workmen's Compensation.—Cotton manufacturing firms have received a circular from the Home-office relating to the Workmen's Compensation Act, 1906. This Act, which came into force on 11th July, 1907, empowers the Home-office to demand from every employer in every industry a return specifying the number of injuries in respect of which statutory compensation has been paid during the previous year, and the amount of such compensation, together with such other particulars of the compensation as the Home Secretary may direct. The present circular gives particulars of the industries to which these regulations apply, and amongst them is "any industry being carried on in any factory to which the Factory and Workshop Act, 1901, applies." The Home Secretary will require information concerning injuries and compensation during the year 1905, and the return has to be made between the 1st of January and 1st of March, 1909. The returns can be supplied by insurance companies or any association of employers, when such companies and associations agree to supply them. The penalty for not supplying the information required by the Home Secretary is £5.

West African Cotton.—The British Cotton Growing Association is making progress with cotton cultivation in Nigeria. The Association has just opened a new ginnery at Oshogbo. It was only last summer that the Association began buying at Oshogbo. The plant is described as the finest and the most complete yet erected by the Association, and it will be able to turn out 10,000 bales per annum when running full time as it is expected to do next year. It consists of two batteries of four gins each, and there is also a large hydraulic press by which the cotton is pressed into compact bales of 400 lbs. with a density of 28 lbs. per cubic foot. The average American bale has a density of about 22 lbs. per cubic foot. The cotton is conveyed to the gins by pneumatic attachment, and by the same means is carried to the condensor and delivered to the press. Not only is there a great saving of labour but the cotton is thoroughly opened out and cleaned. To-day the best lots of Nigerian cotton are selling at $\frac{1}{4}$d. to $\frac{3}{4}$d. per lb. over "middling American." The motive power is obtained from four vertical steam-engines and three boilers of the locomotive type, with fire boxes specially constructed to burn coal, wood, or cotton-seed. The Lagos railway will soon reach Ilorin, where it is intended to erect a similar ginnery. The Association is doing a national work in encouraging cotton cultivation within the Empire. Nigeria alone is capable of producing more than sufficient cotton to meet the Lancashire demand.

Railway Coal Bills.—In a series of elaborate tables the *Statist*, of February 29th, gives the results of the 19 principal railway companies for the half-year ended December 31st last, in contrast with the results for the corresponding half of 1906, and a noticeable feature of the returns is the increase in the expenditure upon coal and the varying effect of the high prices ruling. Thus, the increase in the coal bill of the Hull and Barnsley was 47 per cent., of the London and North-Western 35 per cent., of the Great Eastern 33·8 per cent. The London and North-Western spent upon coal no less than £157,468 in excess of the expenditure for the corresponding months of 1906, and the Midland £89,018; but the southern lines did not suffer in the same way, which is due to the fact that the price they pay consists first of the price at the collieries, and next of the cost of conveyance, and as the latter bears a considerable portion of the total price, and does not fluctuate, the percentage increase in price is greatly diminished. Taking the 19 companies, the increase in their coal bill for the six months was £635,223, or 26·4 per cent.

Labour Disputes.—After seven weeks the Clyde shipyard coppersmiths returned to work on Monday last, having accepted the masters' reduced terms. It is expected that the tin-plate workers and the sheet-iron workers will also resume work shortly, and if they do there will be shipbuilding peace once more upon the Clyde. At the time of writing the result of the engineers' ballot is not known.

CORRESPONDENCE.

PROBLEM OF ROAD CONSTRUCTION.

The authors of the above paper state on page 379 of the *Journal* that only steel-covered roads would stand the wear of the new studded tyre with projecting steel studs. I wish to point out that a road composed of rubber blocks or some form of gutta-percha would stand the wear for a very considerable time; but, as Mr. P. J. Thomas remarks in the discussion, it is mostly a matter of £ s. d. If it were not so, I should consider that for town use, in place of the present wooden blocks, some kind of rubber, gutta-percha, or substitute in the form of blocks or thick sheets, would solve the problem of road covering. Rubber being noiseless, waterproof, pliable, and cleanly: also having rubber to rubber in the case of motor-cars.

The question, of course, of the first cost of such an undertaking makes it utterly out of the question.

D. R. BROADBENT.

Lonsdale-mansions, Tunbridge Wells,
February 29, 1908.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 11.—"The Use of Reinforced Concrete in Engineering and Architectural Construction in America." By ERNEST R. MATTHEWS, F.R.S.E. SIR ALEXANDER BINNIE will preside.

MARCH 18.—"Impressionist Painting: its Genesis and Development." By WYNFORD DEWHURST The EARL OF PLYMOUTH, C.B., will preside.

MARCH 25.—"Recent Improvements in Decorators' Materials." By A. S. JENNINGS.

APRIL 1.—"Dr. Schlick's Gyroscopic Apparatus for Preventing Ships from Rolling." By M. WARD. SIR WILLIAM HENRY WHITE, K.C.B., F.R.S., will preside.

APRIL 8.—"Technical Education in America." By SIR WILLIAM H. PREECE, K.C.B., F.R.S.

APRIL 29.—"Modern Roumania." By ALFRED STEAD, Consul-General for Roumania. SIR PERCY SANDERSON, K.C.M.G., will preside.

MAY 6.—"The Gramaphone, and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

MARCH 12.—"Progress in the Native States of India during the past Forty Years." By SIR DAVID W. K. BARR, K.C.S.I., Member of the Council of India. The RIGHT HON. LORD CURZON OF KEDLESTON, G.C.S.I., G.C.I.E., will preside.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

March 24.—"The Mineral Resources of Western Australia." By the Hon. C. H. Rason, Agent-General for Western Australia.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

March 31.—"Enamel Portraits." By Cyril Davenport, F.S.A. Sir Hubert von Herkomer, C.V.O., R.A., will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Professor Vivian B. Lewes, "Fuel and its Future." Four Lectures.

Lecture I.—March 9.—The formation of fuel—The storage of energy during the growth of vegetation—The formation of cellulose, and its conversion into wood, peat and coal—Natural liquid and gaseous fuels.

Lecture II.—March 16.—The fuel supplies of the world—The uses of fuel and the past demand—The existing supplies and the future—The necessity for immediate economy, and the lines on which it is possible—The calorific value of our fuels, and the amount utilised in practice—Fitting fuel to the work it has to do.

Lecture III.—March 23.—The smoke problem—Bituminous coal unfitted for any fuel purpose—Smokeless fuels—The question of high *versus* low temperature carbonisation in the manufacture of illuminating gas—The gas industry and its work in the future.

Shaw Lectures on Industrial Hygiene.

Tuesday and Friday evenings, at 8 o'clock :—

March 17 (Tuesday).—"Child Workers and Wage Earners." By Miss Nettie Adler, Hon. Secretary to the Committee on Wage Earning Children.

Howard Lectures.

Thursday evenings, at 8 o'clock :—

H. S. Hele-Shaw, LL.D., F.R.S., "The Navigation of the Air." Three Lectures. March 19, 26, April 2.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 9...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Vivian B. Lewes, "Fuel and its Future." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned discussion on paper by Mr. W. G. S. Rolleston, "The Small Holdings and Allotments Act, 1907."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Lieutenant E. Steel, "Exploration in Southern Nigeria."

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, March 10...Asiatic, 22, Albemarle-street, W., 4 p.m. Dr. G. A. Grierson, "The Modern Hindu Doctrine of Works."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Stirling, "Membranes: their Structure, Uses, and Products." (Lecture V.)

Women's Guild of Arts, Clifford's-inn, Fleet-street, E.C., 8½ p.m. Mrs. Herringham, "Indian Architecture."

Civil Engineers, 25, Great George-street. S.W., 8 p.m. Discussion on Mr. William Barclay Parsons paper, "The New York Rapid-Transit Subway."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Mr. A. R. Colquhoun, "Our East African Empire."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Wednesday, March 11...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Ernest R. Matthews, "The Use of Reinforced Concrete in Engineering and Architectural Construction in America."

Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

Meteorological, 25, Great George-street, W., 7½ p.m. Dr. G. Hellmann, "The Dawn of Meteorology."

Auctioneers' Institute, 34, Russell-square, W.C., 7¾ p.m. Mr. Ernest Runtz, "Hostelries: Ancient and Modern."

Japan Society, 20, Hanover-square, W., 8½ p.m., Mr. L. Binyon, "Some Phases of Japanese Painting."

Huguenot Society of London, Windsor Hotel, Victoria-street, S.W., 8 p.m. Mr. Cyril Davenport, "Miniatures."

Thursday, March 12...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Sir David W. Keith Barr, "Progress in the Native States of India during the past Forty Years."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Junior Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Mr. E. Strange, "Japanese Prints."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sir John Rhys, "Early British History and Epigraphy." (Lecture II.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Sir W. H. Preece, "America Revisited, 1907."

Mathematical, 22, Albemarle-street, W., 5½ p.m.

Friday, March 13...Royal Institution, Albemarle-street, W., 9 p.m. Chevalier G. Marconi, "Transatlantic Wireless Telegraphy."

Astronomical, Burlington-house, 5 p.m.

Junior Engineers, United Service Inst., Whitehall, S.W., 8 p.m. Mr. George T. Bullock, "Automatic Fire Extinction as applied to Factories."

Physical, Royal College of Science, South Kensington, S.W., 5 p.m. 1. Professor G. H. Bryan, "Certain Dynamical Analogues of Temperature Equilibrium." 2. Miss D. D. Butcher, "Experiments on Artificial Fulgurites." 3. Mr. S. Russ, "The Distributions in Electric Fields of the Active Deposits of Thorium and Actinium."

Saturday, March 14...Royal Institution, Albemarle-street, W., 3 p.m. Professor J. J. Thomson, "Electrical Discharges through Gases." (Lecture II.)

Journal of the Royal Society of Arts

No. 2,886. VOL. LVI

FRIDAY, MARCH 13, 1908

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 16, 8 p.m. (Cantor Lecture.) PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." (Lecture II.)

TUESDAY, MARCH 17, 8 p.m. (Shaw Lecture on Industrial Hygiene.) MISS NETTIE ADLER, "Child Workers and Wage Earners."

WEDNESDAY, MARCH 18, 8 p m. (Ordinary Meeting.) WYNFORD DEWHURST, R.B.A., "Impressionist Painting: its Genesis and Development."

THURSDAY, MARCH 19, 8 p.m. (Howard Lecture.) H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." (Lecture I.)

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 9th inst., PROFESSOR VIVIAN B. LEWES delivered the first lecture of his course on "Fuel and its Future."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, March 12; The RIGHT HON. LORD CURZON OF KEDLESTON, G.C.S.I., G.C.I.E., in the chair.

The paper read was "Progress in the Native States of India during the past Forty Years." By SIR DAVID W. K. BARR, K.C.S.I., Member of the Council of India.

The paper and discussion will be published in a future number of the *Journal*.

SWINEY PRIZE.

The Council have to give notice that the next award of the Swiney prize will be in January, 1909, the sixty-fifth anniversary of the testator's death. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup, value £100, and money to the same amount; the award is made jointly by the Royal Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A.

In accordance with the arrangement with the College of Physicians, the award next year will be for Medical Jurisprudence.

Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter, addressed to the Secretary of the Society.

The following is the list of the recipients:—

1849. J. A. Paris, M.D., and J. Fonblanque, for their work, "Medical Jurisprudence."

1854. Leone Levi, for his work, "The Commercial Law of the World."

1859. Dr. Alfred Swayne Taylor, F.R.S., for his work, "Medical Jurisprudence."

1864. Henry Sumner Maine (afterwards K.C.B.), D.C.L., Member of the Legislative Council of India, for his work, "Ancient Law."

1869. William Augustus Guy, M.D., for his "Principles of Forensic Medicine."

1874. The Right Hon. Sir Robert Joseph Phillimore, D.C.L., for his "Commentaries on International Law."

1879. Dr. Norman Chevers, for his "Manual of Medical Jurisprudence of India."

1884. Sheldon Amos, M.A., for his work, "A Systematic View of the Science of Jurisprudence."

1889. Dr. Charles Meymott Tidy, F.C.S., for his work, "Legal Medicine."

1894. Thomas Erskine Holland, D.C.L., for his work, "The Elements of Jurisprudence."

1899. Dr. J. Dixon Mann, F.R.C.P., for his work, "Forensic Medicine and Toxicology."

1904. Sir Frederick Pollock, Bart., and Professor F. W. Maitland, for their book on "The History of English Law before Edward the First."

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1908 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before Saturday the 4th April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For.Memb.R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For.Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For.Memb.R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For.Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (afterwards Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham).

In 1887, to HER MAJESTY QUEEN VICTORIA.

In 1888, to Professor Hermann Louis Helmholtz, For.Memb.R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph (now Lord) Lister, F.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

In 1896, to Prof. David Edward Hughes, F.R.S.

In 1897, to George James Symons, F.R.S.

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For.Memb.R.S.

In 1899, to Sir William Crookes, F.R.S.

In 1900, to Henry Wilde, F.R.S.

In 1901, to HIS MAJESTY THE KING.

In 1902, to Professor Alexander Graham Bell.

In 1903, to Sir Charles Augustus Hartley, K.C.M.G.

In 1904, to Walter Crane.

In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.

In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.

In 1907, to the Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

February 25, 1908; The EARL OF CROMER, O.M., G.C.B., G.C.M.G., K.C.S.I., in the chair.

The CHAIRMAN, in introducing the author of the paper, said that Lord Milner, in his classic work on Egypt, spoke of Sir Colin Scott-Moncrieff and his associates as the saviours of Egyptian irrigation. He thought he could improve on those words. It was no exaggeration to say that they were the saviours of Egypt. Without their help there could have been no financial rehabilitation, and without financial rehabilitation there could have been none of the moral and material improvements which had taken place of late years.

The paper read was—

IRRIGATION IN EGYPT UNDER BRITISH DIRECTION.

By Sir Hanbury Brown, K.C.M.G.

The Binding of the Nile.

The Royal Society of Arts did me the honour to invite me, in the first instance, to read a paper on "the work accomplished in Egypt under the ægis of England." This I had to decline, as not only beyond my powers, but as being too large a subject for a single paper. So the invitation was modified, and the paper has accordingly been restricted to a survey of irrigation in Egypt under British direction. Even thus, I find my subject has too wide a spread to be confined within the limits assigned, without undue compression; and so something has to be shut outside. I have, therefore, excluded the basin tracts of Upper Egypt and the whole Sudan from my survey. Basin irrigation, on the one hand, is a system unfamiliar even to most irrigation engineers, and any attempt to make it intelligible to you, so that you might appreciate the reforms introduced in its working, would take too long and would very likely prove tedious. Sudan irrigation, on the other hand, is, as yet, only in the preliminary stage of study. Sir William Garstin's personal inspections of the White Nile, extending over five years, and his expedition to the Equatorial Lakes at the sources of the White Nile, as also Mr. C. Dupuis' expedition up the Blue Nile to Lake Tsana, were the arduous beginnings of irrigation in the Sudan under British direction. Sir William Garstin's "Report upon the Basin of the Upper Nile" is the preface to its future history. Mr. Dupuis and his staff are now busily engaged in collecting reliable data for solving the many interesting problems of the Upper Nile, on which not only the development of the Sudan, but the further development of Egypt depends. Interesting though these problems are, they are still unsolved problems, and have no place in a paper which deals with the actual results of work accomplished. So I do not propose to cross the Southern boundary of Egypt, though the binding of the Nile can never be made complete within the limits of Egypt proper. Nature has ordained that the lands of the papyrus and the lotus—of the Upper and Lower Nile—must unite in the binding of their common river.

The device, which serves as first illustration to this paper (p. 416), was designed some 4,000 years ago. It is a not uncommon one to find on the pedestals of the royal statues of Ancient Egypt. It symbolises the union of the Upper and Lower Nile countries under the control of a single ruler, and is called "The Binding of the Two Lands." The two figures represent the well-fed gods of the Upper and Lower Niles binding together the lands of the lotus and papyrus into one united kingdom under the Pharaoh, whose cartouche is carved above the sign of Union and Control about which the binding takes place. Viewed as an illustration of modern history, the gods may serve to personify the British occupation of Egypt and the condominium in the Sudan. Or, if so preferred, let the god of the lotus be Lord Cromer, and the other of the papyrus Lord Kitchener, binding with firm grip the two countries together under the supreme control of the British Government.

The Placing of Irrigation under British Direction.

Over 70 years ago, Kinglake, in the pages of his "Eothen," prophesied that the Englishman, leaning far over to hold his loved India, would plant a firm foot on the banks of the Nile, and sit in the seats of the Faithful, while the sleepless Sphinx would lie watching and watching the works of the new busy race. On 13th September, 1882, 47 years after the prophecy was made, the battle of Tel-el-Kebir was fought, and a foothold established by the English on the banks of the Nile, a foothold to grow firmer from day to day. Ever since that battle was fought the Sphinx lies watching the transformation scene which, under the hands of the new busy race, began then to unfold itself. And what a scene, brighter than dreamer's visions, has developed through the waving of Lord Cromer's fairy wand! A nation bankrupt and degenerating, minished and brought low through oppression, has been transformed into a people rich and growing richer, enjoying the blessings of equal laws and good government; and endowed with such growing prosperity that there is now assurance of the fulfilment of another prophecy made in 1898, that, "for its size, the province of Egypt would become the most valuable domain on the face of the globe."*

I shall not presume to single out those who, it may seem to me, have contributed most to the regeneration of Egypt; but I think I may venture the statement that the Finance and Irrigation were the two Departments which,

* "Egypt in the Nineteenth Century." Cameron.

together, took the lead in redeeming Egypt. For, in order that Egypt might pay its way without the exhaustion that must end in bankruptcy, it was imperative that the country should be made to produce more and to waste less than it had been doing during the rule of Ismail. A sound administration of finances and an intelligent direction of irrigation were then the two things necessary to set the country on its legs. The Finance Department invested the country's money in irrigation, and the Irrigation Department gave it a return of sometimes a hundred per cent. or more.

As a financial expert Lord Cromer himself was competent to guide the operations of the Finance Department, so that, whatever was done and whoever might be the British Adviser of the Khedive in this Department, there was good security that soundness would be the characteristic of its policy.

But it was different with the Irrigation Service. For the proper control of Egypt's water-supply there was absolute need of a man who had gained experience in the practical working of canal systems. So a well-known irrigation engineer of India, on his way home to England, was waylaid by Lord Dufferin in the Suez Canal and captured for Egypt. Sir Colin Scott-Moncrieff was the man. Though he was formerly my chief, I hope it will not be reckoned an impertinence if I express my opinion as to his fitness for the post. I am only voicing the unanimous judgment with reference to his appointment when I say that probably no better choice could have been made. In his position as head of the Irrigation Department he had need of broad views of irrigation matters. He required, in addition, the attributes of an administrator of consummate tact to qualify him to deal, on the one hand, with his own staff officers—the inspectors of irrigation—who were at times unduly restive, being animals of high mettle; and, on the other, with Consuls-General and their kind, who had various axes of their own which they thought Sir Colin might be in a position to grind. His success was conspicuous

Fig. 1.

The Binding of the Two Lands.

and lasting. He preserved the peace within and without the Department, and organised it on such sound lines that its performances, I feel bold to state, have satisfied not only others, but himself as well.

Let us now pass in review what it is that the Irrigation Department in Egypt has done since it was put under British direction, in May, 1883, the date of Sir Colin's appointment by the Khedive on the nomination of Lord Dufferin.

The Pioneer Stage of Control.

During the latter half of the year 1883, Sir Colin "went throughout all the land of Egypt" to make himself acquainted by personal inspection with the conditions of the problem with which he had to deal. Within twelve months from the date of his appointment his staff of four engineers of the Indian Irrigation Service had joined him. They were made Inspectors of Irrigation, and were forthwith sent to their posts to take charge of their respective Circles, with instructions to do what they could to put things right, and to spend as little money as possible; for Egypt was then on the verge of bankruptcy.

It is not good form to decry the work of one's predecessors, even truthfully; but this I think I may be allowed to say, that the new Inspectors of Irrigation found so much that required doing to set things right that it was difficult to decide what first to take in hand. They had to learn a new language and a new country. They had to assert authority over their own staff of native engineers—no difficult task with the ready backing at headquarters of which they were assured. They had to encounter numerous vested rights, and overcome the open or hidden opposition of the native governors of provinces: they had above all to inspire the people with confidence in their honesty and ability. That they did not fail to do this was because they were British gentlemen devoted to their task.

Justice in the Distribution of Water.

Without money, one would naturally say they could do little. But they did a great deal. The just distribution of water to rich and poor alike was one of their most important duties. Hitherto the Irrigation Service had been under the nominal control of superior officers who never left Cairo. Actually it was controlled by the governors of provinces or local landowners of influence. Material evidence of what went on in the "good old times," before Britishers interfered, was fairly abundant. Halfway down the main canal which irrigated Middle Egypt I found, soon after taking over my charge, the remains of a stone dam which Sultan Pasha, once the most influential man in Middle Egypt, had made when the water supply was short, so as to divert all the available water on to his own lands. The native engineers certainly, and the governors of provinces probably, would not have dared to question his right to do so. It would not have occurred to them that the poorer cultivators were being robbed of their due share of the precious water, most precious when there is least of it. They probably even *made* the dam for the Pasha by means of forced labour, compelled to work without pay by Government officials under the barbarous system of the Corvée.

From the very first, then, inasmuch as something could be done in this direction without money, and money there was none, the new reformers set themselves to introduce equality of distribution of water to rich and poor alike. So strange and novel a proceeding was this and so difficult for the previously privileged class of pashas and rich to accept, that the English inspectors were accused of injustice towards the rich in riding their hobby o justice to the poor. I will illustrate this by an incident which occurred in connection with my own work, as indicating the difficulty of the situation of the inspectors, placed as they were nominally under a Minister whose sympathies were with the pasha class. Sultan Pasha, already mentioned, had died shortly before I appeared on the scene—fortunately for me, as he would have been a difficulty the more; but he had heirs who attempted to carry on the old traditions. One of them filled up a poor man's field channel, and thus cut off his water supply. I ordered the reconstruction of the channel and the restoration of the water supply, and wrote a strong letter to the Governor calling upon him to see to it. Meantime I was summoned to Cairo. The Pasha's heir had written to the Minister of Public Works about my interference—what, I do not know. The Minister sent for me, and I explained the matter to him. All that I remember of the conversation is that the Minister, in virtuous tones, impressed upon me that there was such a thing as justice for the rich as well as for the poor. Finally, I left him without having given way upon the point, and saying I would find out whether my order had been executed or not. I sent a cu-

telegram to the Governor from the Ministry, simply asking him if my order had been carried out. The Governor, noticing the place of despatch and fearing that I should report him for non-compliance with the order, promptly replied that the channel had been re-dug and the water was flowing. That was what I wanted—a *fait accompli*. However, the Minister made no further move, and I left things alone, merely satisfying myself on my return to my Circle that the Governor's report coincided with facts. Months after, when the Minister visited my Circle, he suddenly called to mind the case and asked what had happened in the matter; and I told him that my order had been duly carried out and the poor man's water supply restored: and no further reference to the subject was thereafter made between us.

Such glaring cases of interference with water distribution by the richer landowners were the first abuses in this direction which were dealt with, and with such good effect that at length they became quite rare. It was encouraging, during periods of scarcity of water, to receive reports that the native irrigators were breaking each others' heads in their efforts to settle irrigation questions among themselves. We knew then that the water had reached the class of cultivator that finds *nabouts* the readiest and most convenient form of argument. A *nabout* is a stout stick of a kind well calculated to convince if wielded with any skill. But such a condition of things could only be considered satisfactory as being a stage in advance of what had been before. The water had reached the lands of the poorer classes, but its control could not be left to the strongest arm any more than it could be permitted to the longest purse. Gradually the Inspectors of Irrigation acquired a more efficient control over the water, and introduced more scientific systems of distribution, until, at length, the confidence placed in their ability, honesty of purpose and disinterestedness, was so firmly established, that the *nabouts* were put away and irrigation disputes were referred to the English inspector for settlement as the better way. It is seldom now that any agriculturist in Egypt in want of water takes the law into his own hands. The life-giving waters of the Nile no longer bear the reproach of being waters of strife.

The Corvée and the Kourbash.

Distribution of water, however, is not possible without some means of maintaining the channels and banks of irrigation systems. In the early days of the British Occupation, the funds at the disposal of the State were utterly inadequate to pay for even such work as was absolutely necessary to the continued existence of Egypt as an inhabited portion of the globe. But a substitute for work paid for by money was found in a system of long standing in Egypt—the system of the Corvée, or of work which was not paid for. Under this system, the peasants were dragged away from their villages, sometimes to considerable distances, and made to work without pay. Nor were food or shelter provided: the women and children of the village had to see to the food supply from their own resources. The want of shelter was, as a rule, no great hardship in such a climate as Egypt; but, in Lower Egypt, there is, in winter, occasionally rain, and cold intense enough to cause distress to the poorly clad.

As a necessary accompaniment of the Corvée, there was the lash, commonly called the "kourbash." This instrument of torture was usually applied to the soles of the feet, and was much in favour with men in authority or power as the officially recognised instrument of extortion or compulsion. If work has to be done, and there is no prospect of any pecuniary or other reward to induce the labourer to work, he must be forced to work by the stimulus of punishment. So long as the Corvée system existed, it was difficult to do without its inhuman concomitant.

Bad as the Corvée was when administered in accordance with the Khedivial Decrees regulating its employment, it was in practice unspeakably worse by reason of the abuses to which it lent itself. In the days when despotism had a free hand in Egypt, the unpaid and unfed labour of the poorest of the peasantry was enforced to execute, not only works of benefit to the State, but the private undertakings of the Khedive and of influential landowners as well. There was no limit to the numbers impressed, no check on the rigour of the task-masters.

Here, then, was a burden to be lifted from the shoulders of the poor. But for want of money the suppression of the Corvée had to wait. All that could be done in the early days of reform was to remove the abuses, restricting the employment of the Corvée to works of public usefulness, duly authorised, and forbidding the use of the kourbash.

Meantime the irrigation officers had to make

use of this clumsy and wasteful human instrument to get the necessary clearances of canals and repairs to banks executed. If, in those days, they complained of their tools, it was not because they were bad workmen: they did the best they could with this unwieldy tool of clumsy make and bad metal. But the real value of the work done by the Corvée was absurdly low when compared with the estimate of the proper value of the labour employed in doing it. The system was wasteful, inefficient and unmanageable, to say nothing of its inhumanity. How it continued its work after the official suppression of the kourbash would be a mystery, were it not an open secret that the kourbash continued active behind the scenes till the necessity for it ceased later on with the total suppression of the Corvée.

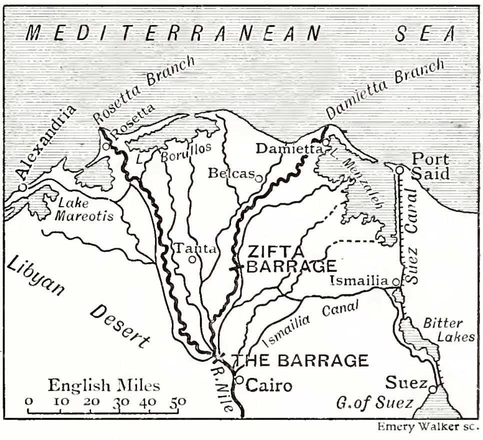
In 1884, the number of unpaid labourers impressed was, according to official reports, equivalent to 165,000 men working for 100 days. If we take three piastres as the daily wage, the money value of this labour would be about £500,000. But, even with this large army of labourers, the necessary work to maintain the canals in a state of efficiency was yearly falling into arrears. The introduction of cotton cultivation into Lower Egypt had necessitated the digging of deep canals with their beds cleared below the summer levels of the river, so that they might draw in water from the Nile throughout the summer for the irrigation of the cotton crop. These deep channels silted up badly during every flood, and the Corvée was found unequal to the task of clearing them properly before the time when water had to be admitted for the cultivation of the cotton crop. Something had to be done to save the situation.

The Delta Barrage.

An attempt had been made to avoid the necessity of maintaining deep canals by raising the river water-level artificially at the head of the Delta. With this object a barrage, or river regulator, had been built across each of the Damietta and Rosetta branches of the Nile close below the point of bifurcation, some 15 miles north of Cairo. The work was designed to raise the natural water-level of the river at that point by 15 feet. Its construction was begun in 1843 by Mougel Bey, a Frenchman, and was supposed to have been complete in 1861. But the foundations had been so carelessly laid, and were so defective in consequence, that, when the work was subjected to a head of water in 1867, it showed such unmistakeable signs of failing that all attempts to use it for its original purpose were abandoned.

The accompanying map of Lower Egypt, Fig. 2, and the plan showing the river and canal works at the head of the Delta, Fig. 3, will help to make plain what it was that the Barrage had been designed to do. The two river regulators, which together constitute the Delta Barrage, serve to dam the two branches close below the point of bifurcation during seasons of low supply, and to raise the water-level of the pond which is thereby formed in the river channel upstream of them. The main canals, which irrigate the Delta, take off directly from this pond through controlling head-sluices.

Fig. 2.



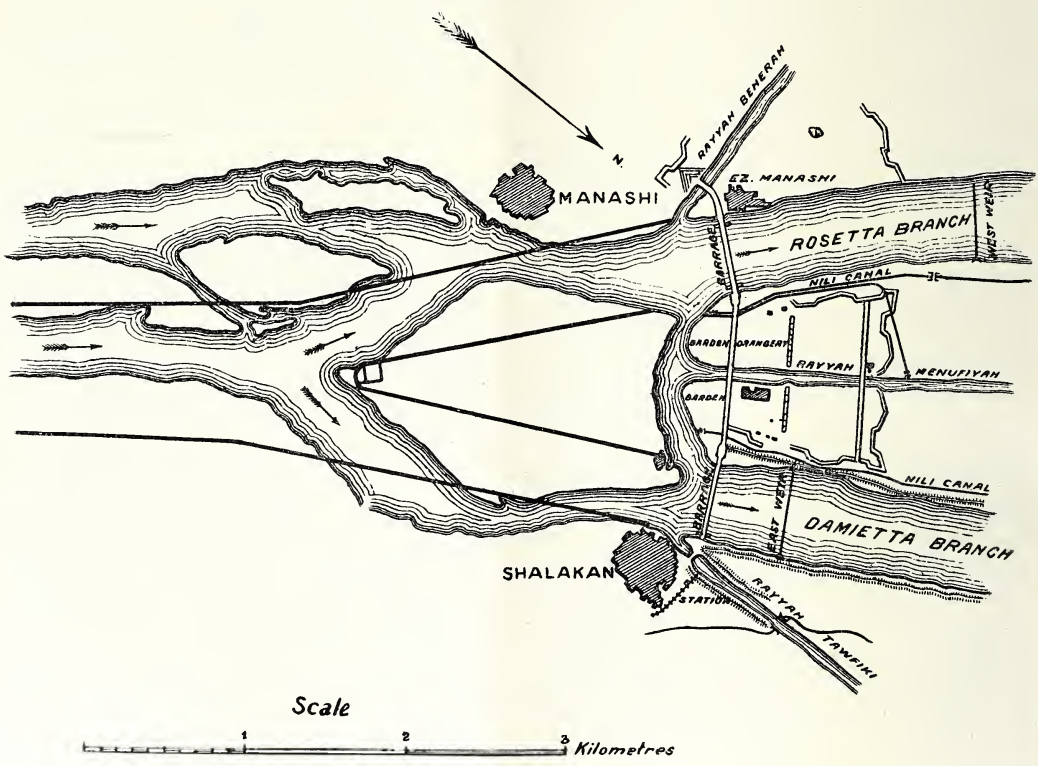
Lower Egypt or the Delta.

In the Annual Report on Irrigation of 1883, issued by the Public Works Ministry at Cairo, the Barrage was declared to be valueless except as a bridge over the Nile and a distributor of the river discharge between the two branches. As the Barrage was thus pronounced incapable of raising the river levels in summer, it was recommended to adopt a project for irrigating the whole of Lower Egypt by means of pumps at an initial cost of £700,000 and an annual outlay of £248,550. It was at this critical moment that Sir Colin Scott-Moncrieff appeared upon the scene as one born in due time. The country was fortunately not committed to the pumping project, so Sir Colin could reconsider the question. At the end of 1883, Mr. (now Sir William) Willcocks was put in charge of the Barrage to examine and test it, with the result that it was decided to shelve the pumping project and rely on a restored barrage, or

some similar substitute, for the irrigation of the Delta. In 1885, a loan of a million pounds was obtained for irrigation expenditure, and Lieut.-Colonel J. H. Western and the late Mr. A. G. W. Reid came from India to direct the works which were to be built with the million. The restoration of the existing barrage was decided on, and was the principal work for which the million was demanded. The work of restoration occupied five working seasons, and was successfully carried to completion by the two engineers named. On the 16th June, 1890, the work below water-level was reported complete.

The Delta Barrage is the most important irrigation work in Egypt, for upon it the wealth of the country chiefly depends. Each of the two regulators, which together constitute what is known as "The Barrage," is made up of 61 openings of 5 metres width. Each opening is fitted with a pair of iron gates sliding in vertical grooves, by which the waterway can be dammed to the height necessary for forcing the river discharge into the canals. Before Colonel Western's restoration work, the regulating apparatus was entirely wanting on one section of the Barrage, and on the other was incomplete and defective: the foundation platform was full of faults and traversed by springs, and was in no fit state to serve as a floor to a regulator of the river levels. To remedy this state of things a skin of sound masonry was laid over the old defective floor, with apron extensions up and down stream. At the same time the springs were properly staunched. This difficult piece of work was so skilfully and thoroughly carried out that the Barrage was made strong enough to hold up 13 feet head of water.

FIG. 3.



RIVER AND CANALS AT THE DELTA BARRAGE.

CEMENT-GROUTING THE BARRAGE FOUNDATIONS.

But below the new skin which had been formed over and beyond the old floor there still existed the original defects in the foundation material. To consolidate this, a rather remarkable operation was carried out. Bores were jumped in the thickness of the piers from the roadway level 51 feet downwards to the underside of the

lowest layer of masonry. Into each of the bores cement grout was poured continuously till the grout rose in the bore to roadway level. By this process the cement grout forced itself by the pressure of its own liquid column into all cavities, in or under the floor, and, by its property of setting under water, compacted together all that was loose or disintegrated within its reach.

The Barrage Weirs.

Lastly, weirs * have been constructed downstream of the barrage on either branch, with the object of relieving the original structure of some of its work and, at the same time, of increasing its powers of control over the river, so that it has now been made possible to head up the river in summer to an artificial height of 20 feet, instead of 13 feet only. Consequently every drop of the summer Nile which reaches the head of the Delta is forced into the canals which carry it to the crops to be irrigated. Absolutely no water is allowed to flow past the Barrage along the natural channels of the river below it until such time as the rising flood has caused the canals to run with liberal discharges.

The Abolition of the Corvée.

The successful accomplishment of these important engineering operations was attended or followed by important results. As has been stated, the restoration of the Barrage in its first stage, before the weirs had been built, had secured to the engineers in charge the power of raising the summer level of the river above it by 13 feet. It does not require technical knowledge to understand that, if the water level at the canal off-takes is raised, the bed level of the canals may be raised by an equal amount without reducing the quantity of flow into the canals. It is, therefore, easy to understand how it was that a great reduction in the labour of clearing the Delta canals resulted from the Barrage restoration. The reduction of silt clearances had been gradually effected in the canals of Egypt generally by the application of scientific methods of water distribution which the Anglo-Indian engineers had introduced; but the restoration of the Barrage was the operation that produced the greatest effect in this direction, and must be given the largest share of the credit for bringing about conditions which made it possible to arrange for the abolition of the Corvée.

* Completed in May, 1901.

Thus, by the employment of means to reduce the deposit of silt, by providing protection for banks exposed to water action, and by the elimination of useless work, the irrigation staff had so reduced the cube of earthwork which it was necessary to execute annually, that the cost of getting it done by contract, instead of by forced labour, was brought within the means of the country's financial resources. The sum of £400,000, which the irrigation officers estimated was annually required to pay for the work that had hitherto been carried out by unpaid labour, was provided by the Finance Ministry as soon as the finances had sufficiently improved to allow of this being done, and the Corvée came to an end like a bad dream.

Contract *vice* Corvée Work.

The process of suppressing the Corvée was spread over several years. For a few years contract and Corvée labour worked side by side, part only of the sum required for total abolition being at first provided. In this way the change from the one system to the other was not inconveniently abrupt. Most of the native governors of provinces disliked the change, as it transferred the control of much that added to their power from their hands to the Inspectors of Irrigation. Consequently, on the first introduction of contract labour, the governors sent reports to headquarters complaining of the way in which the contract work was being carried out. Their reports were founded on prejudice only, and in no wise on facts, and the relations between the governors and the inspectors were strained in consequence. The conflict between the Governor of Assiout and myself concerning this matter of contract work became at one time so acute that it seemed as though one of us must be removed from the other's sphere of action. The Governor was an Egyptian of the old type, who had an aversion to Europeans and all that made for progress, and whose delight was in the kourbash. He had been accustomed to govern without sharing his autocratic power with any rival, and the English chiefs of the Irrigation and Police were as an evil odour in his nostrils. It was not, however, the policy of the Minister of the Interior at that particular time to oppose the new reformers, and the Governor, being restive, was summoned to Cairo to be instructed accordingly. A few days after, my native Chief Engineer asked me, with a smile on his face which he vainly

tried to suppress, if I had heard about the Governor of Assiout. I said, "No." He then told me that, after having an interview and a cup of coffee with the Minister of the Interior, the Governor went home and died suddenly. Probably the Minister hurt his feelings, and produced such an effect that one of his fits, to which he was subject, was brought on and was the death of him. But the Eastern mind would not accept that view. I found, to my horror, that the seeming opportuneness of the event, as far as I was officially concerned, pointed to a connection between me and the sudden disappearance from the scene of my troublesome opponent.

The abolition of the Corvée was a reform only to be fully appreciated by those who had had personal experience of the working of this form of slavery. The peasantry, who were thus freed from servitude, were no doubt those who felt the most lively sense of relief.

Other Results of the Delta Barrage Works.

But the removal of this burden was not the only result of the full development of the working powers of the Barrage. In consequence of the better water supply obtained in summer by its action, the cotton crop, on which the wealth of Egypt depends, had been doubled, having increased from 3,000,000 to 6,000,000 cwt., or in value from £7,500,000 to £15,000,000. As the result also of the greater control obtained over the levels of the rising flood, the timely sowing of the peasants' food crop of maize had been ensured. Further, the cost of raising crops had been lowered in consequence of the reduction of the height to which the water had to be lifted for irrigation. Meantime the cultivated area of Egypt had increased from 5,000,000 to 6,000,000 acres, and the value of land had been doubled; while, at the same time that these benefits were accruing, the land tax had been reduced from £5,000,000 to £4,500,000.

If these results are represented by figures giving their money value, it will be found that the return for the special expenditure of under £4,000,000*, incurred in bringing these results about, was not a hundred per cent. only, but several hundred per cent.

	£
* Delta Barrage restoration and weirs	000,000
Development of Delta canals	800,000
Drainage	1,000,000
Re-modelling Upper Egypt basin system ...	800,000
,, Middle ,, ,, ...	300,000
	£3,800,000

Change of Irrigation Chiefs and Conditions.

During the period of this growth in prosperity, Sir Colin Scott-Moncrieff retired from the Egyptian service, and Sir William (then Mr.) Garstin succeeded him as Under Secretary of Public Works. This change took place in 1892. The financial conditions prevailing during the time that these two respectively held office, were widely different. Sir Colin's task was to make bricks with whatever stubble he could gather in place of straw; Sir William's to make good use of the liberal supply of material that was placed at his disposal. In either case the tale of bricks was complete, and it has been universally admitted that the tasks were fulfilled to the perfect satisfaction of all interested.

Insufficiency of Summer Water Supply.

I have told how the efficiency of the Barrage was brought about, and how its power of holding up water was added to by the construction of subsidiary weirs down stream, so that it was at last capable of holding up 20 feet of water. As the growth of the cotton crop had kept pace with the increase of the canal discharges, it came to pass that the total water supply furnished by the river in summer, was fully utilised in irrigation, and in bad years was insufficient to meet the needs of the crop. The canals drew off all the river water when the heading up at the Barrage was some 6 or 7 feet short of the maximum permissible. Not a drop was allowed to pass the Barrage gates. The leaks even round the gates, and between the pairs of gates, were stopped by caulking with rags.

The ability of the Irrigation Department to meet the summer demand for water was tested to the uttermost in 1900. Fortunately, by the summer of this year, the construction of the weirs had so far advanced that it was possible, by temporary expedients, to make them come into action as if they had been complete. The flood of 1899 had been the lowest on record, but Lower Egypt had not suffered, as the deficiency of the flood was neutralised by so regulating on the Barrage that the levels of a fair flood were artificially produced in the river. Hitherto an over-cautious rule had been observed which forbade any partial closing of the gates during flood. The very low flood of 1899 was followed by extremely low levels in 1900 during the cotton-crop season. On January 1st, 1900, the river level at Assuan was 6 feet below the average,

and the prospect for the coming summer's water supply was as bad as could be. Early in the year, therefore, the Barrage gates were closed and caulked with rags, and every drop of the river discharge was forced into the irrigation canals, depriving the twin channels of the river below the Barrage of absolutely all their natural supply. But in the 125 miles of channel of either branch, between the Barrage and the Mediterranean, spring and percolation water collects in quantity not to be despised. Therefore, in order to make this spring water also available for irrigation, there were constructed temporary dams—one in either branch some little distance above the point where it joins the sea—with the double object of excluding the salt water and retaining the spring water. This source of supply also was drawn upon till it was exhausted. Further, to make the total available supply do the maximum work possible, its distribution was regulated by an elaborate and severe programme of rotations rigidly enforced. By the system of rotations water is given by turns to the different sections of the cultivated lands according to the rotation programme in force. As a result of these measures the cotton crop of the year 1900 yielded 5,500,000 cwt., which was a higher figure than that of any year previous to 1896. The highest figure reached previously to 1900, namely, 6,500,000 cwt., was that of the year 1897, which was a year of favourable summer levels in the river.

Storage of Water and Assuan Dam.

The summer supply of 1900 was utilised to the last drop and stretched to the limit of elasticity. It had become evident some years before that such a situation would soon be created by the continuous expansion of the area planted with cotton. It was, therefore, foreseen that, if the development of Egypt was not to be then arrested, means must be found for supplementing the summer discharge of the river. So Sir William Willcocks was entrusted with the task of studying the question of reservoirs with the object of preparing a project for storing the surplus water of the flood and winter discharges of the Nile for use during the summer. The construction of the Assuan Dam was decided on as the result of his studies.

The latest calculations give the amount of water, which altogether would have to be stored to provide for Egypt's fullest development, as 6,000 million cubic metres. It was at first decided to build on the crest of the first cataract above Assuan a dam of a height sufficient to store 2,500 million cubic metres, or five-twelfths of the full quantity required. But, as a concession to the vigorous protests of archæologists, artists and others against the submersion of buildings on the Island of Philæ, which some of the protestors had never seen, a height of 26 feet was knocked off the top of the dam in the design. The capacity of the reservoir was thus reduced from 2,500 to 1,000 million cubic metres, that is, from five-twelfths to two-twelfths—or one-sixth—of the full quantity required.

The dam, as built according to the modified design, is $1\frac{1}{4}$ miles long, and contains over a million tons weight of masonry. The greatest height of the dam is 127 feet. It supports a head of water of 67 feet.

Results of Storage by Assuan Dam.

The further expansion of Egypt's prosperity which has followed as a consequence of the construction of the Assuan Dam, and the works subsidiary to it, has not yet reached its full development, and that is probably the reason why the annual official reports of the Irrigation Service have not as yet attempted a statement of results. However, here is one item mentioned in the report for 1906. "The actual benefit which has, up to the end of 1906, resulted to the country (that is, Middle Egypt) from these works is estimated to be a rise of rental value of £E.1,770,000, and of sale value of £E.23,569,000." There were then about 300,000 acres converted from basin to perennial irrigation out of a total of 400,000 acres to be eventually converted.

Basin land is land that is inundated during the flood season and grows one crop of cereals or clover a year. When it is converted from basin to perennially irrigated land—that is, when floods are excluded and irrigation is provided all the year round—two crops a year are grown in place of one, and the rental and selling values of the land are more than doubled. The converted basin lands of Middle Egypt absorb the lion's share of the reservoir water; but the reservoir has also a high importance as providing insurance for the cotton crop of Egypt, valued at about £28,000,000.* Land also in the Fayum Province has risen in value, and the area of cultivation there has extended in consequence of the improved conditions of water supply created by the construction of the Assuan reservoir.

* Blue-book Egypt, No. 2 (1907).

I shall not attempt any description of the dam or its construction, as this is not a society of engineers. Moreover, you probably know as much as could be told you in the short time available for reading this paper. The dam is a work worthy to be praised, and those who helped to make it may be proud of it. Their names are recorded in the various accounts of its construction. The late Sir Benjamin Baker was the consulting engineer to the Egyptian Government for this work, and all who worked on it with him will feel that in losing him they have a personal as well as professional loss to deplore.

As the restoration of the Delta Barrage to usefulness was the most noteworthy material work that distinguished Sir Colin Scott-Moncrieff's term of office, so the Assuan Dam will be reckoned the most remarkable monument of Sir William Garstin's stewardship.

I may here mention that the raising of the Assuan Dam by 5 metres (16 feet 5 inches) has been decided on, and has probably been already commenced. The high-water level of the reservoir will, on the completion of the additions, be raised 7 metres (23 feet), and the capacity of the reservoir will thereby be increased from 1,000,000,000 to 2,300,000,000 cubic metres.

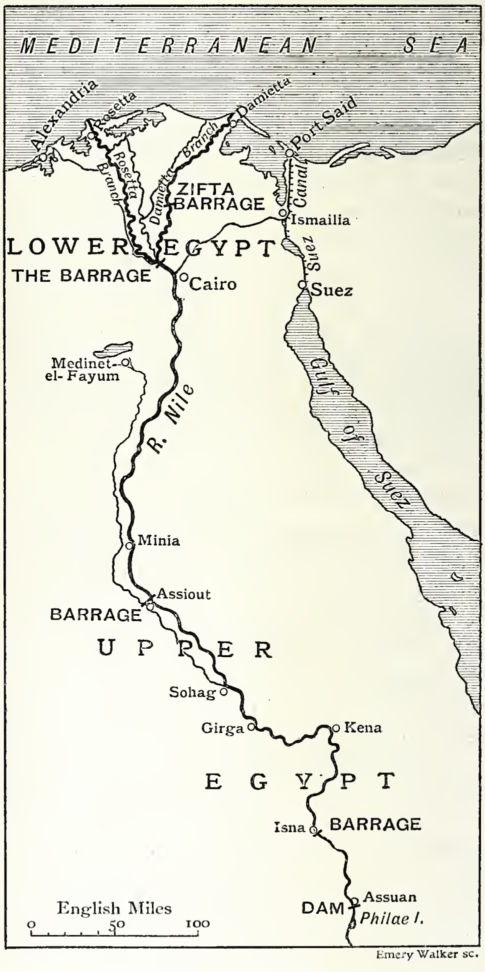
The decision to raise the Assuan Dam has been lately criticised by Sir William Willcocks* in a way which, he himself admits, a diplomat would not have done. He did not know, when he delivered himself of his criticisms, that he was wrong in his facts. He was severe on the decision to raise the dam 7 metres, instead of 6 metres as he himself had proposed, and expressed himself in these words:—"I have tried in vain to fathom the reasons which led the late Sir Benjamin Baker, as Consulting Engineer to the Government, to advise the raising of the dam by 7 metres, when he had resisted its being raised by 6. He might have recommended its being raised by 5 metres as something quite safe." Well, it is by 5 metres that Sir Benjamin recommended that the dam should be raised, and not by 7: it is the high-water-level of the reservoir that will be raised by 7 metres. Sir W. Willcocks's not too delicately worded criticisms of Sir B. Baker, therefore, rest on as faulty foundations as the Delta Barrage originally did. I think it only right that I, being a member of the Institution of Civil Engineers, should take this opportunity of speaking in defence of one of the most esteemed in his profession, now that he cannot do it for himself; not on the principle of *de mortuis nil nisi bonum*, but because there is no justification whatever for the unworthy suggestion that Sir Benjamin's recommendations concerning the raising of the Assuan Dam were influenced by any other consideration than the desire to give the best professional advice in his power to the Egyptian Government.

* Lectures delivered in Cairo to the Khedivial Geographical Society on 21st December, 1907, and 25th January, 1908.

The Assiout, Zifta and Isna Barrages.

Some of the works that I have referred to as subsidiary to the Assuan Dam were themselves works of the first magnitude, such as

Fig. 4.



Map of Egypt.

the Assiout and Zifta barrages. The function of these river regulators is the same as that of the Delta Barrage, namely, to distribute water, not to store it. The Assiout Barrage spans the undivided river at Assiout, and is

the work that controls the distribution of th river water between Lower and Middle Egypt. It is made up of 111 bays or openings of 5 metres width, and a lock for navigation. The Zifta Barrage is built across the Damietta branch, about half-way between the head of the Delta and the sea, and distributes the water of that branch to the canals on either side. It is made up of 50 bays and a lock. Both these barrages are of the same type as, and similar in design to the Delta Barrage.

Yet another barrage is now under construction, the Isna Barrage; but it is not subsidiary to the Assuan Dam, as its function is to artificially raise the levels of a low flood for the benefit of those basin lands of Kena which would otherwise not be reached by the inundation. It is a work similar to the Assiout Barrage, and of 120 bays.

The accompanying map of Egypt includes the sites of all the works referred to. Highest up the river comes the Assuan Dam, 750 miles from the sea. The Isna Barrage, now under construction, is about 100 miles below Assuan. The next work, following the river down, is the Assiout Barrage, 400 miles from the sea. The Zifta Barrage, on the Damietta branch, lies about half-way between the sea and the Delta Barrage.

The Irrigation Department under Sir Colin Scott - Moncrieff and Sir William Garstin.

Sir William Garstin is about to leave the Egyptian service. It would be a pleasant thing for him, I imagine, to be called upon to give an account of his stewardship. For sixteen years he has been Under Secretary of Public Works. During that time there have been built the Assuan Dam, the Assiout and Zifta Barrages, and the weirs below the Delta Barrage; and the Isna Barrage is now under construction. A host of other works of regulation have been built on the canals. Sir William Garstin and his staff have known how to spend to good purpose the large sums of money that the Finance Ministry placed at their disposal.

Sir Colin Scott - Moncrieff's account of stewardship would not take credit for so many mighty works of stone and bricks and mortar; but the immaterial foundation of it all was laid by him in the formation of a Department that compelled confidence in its discretion to decide upon, and its ability to design and carry out, works that would give prosperity to Egypt; and to his period of office belong the restoration of the Delta Barrage and the abolition of the Corvée. With half of the million pounds that were given him he restored the Barrage, the one work more than any other that won the race against bankruptcy. In his "England in Egypt," Lord Milner, once Under Secretary for Finance in Egypt, writes of irrigation matters in Egypt as enthusiastically as if he were an irrigation man himself, and glad am I that he does so. He is a man whose good opinion is much valued by irrigation men and others. Of this irrigation million he writes:—

"It saved the irrigation system, and with it the finances of Egypt. It has brought in cent. per cent. Of all the extraordinary contrasts of which the history, and especially the financial history, of Egypt is so full, there is none more striking than that of the countless millions borrowed by Ismail and this single million for irrigation. The former raised with ease in the heyday of fortune, the latter only obtained after a hard struggle, when Egypt's power of borrowing seemed almost extinct; the former squandered with so little benefit to the country, the latter of such incalculable value in the re-establishment of her prosperity."

The Pioneer Inspectors of Irrigation.

It is nearly five years ago since I left Egypt and its canal works, and it is a treat to me now to sit, on these cold nights, by the fireside and read the chapter on the struggle for water in Lord Milner's delightful book. For I am proud of being one of the pioneer inspectors that joined Sir Colin in Egypt in 1884, and helped to lay the foundation course of bricks, made without straw, upon which has risen so wonderful a superstructure.

As I have not been able to leave all mention of myself out of this paper, I must give myself the pleasure of naming my co-pioneers in irrigation reform in Egypt, under the command of Sir Colin Scott-Moncrieff. First to arrive were the late Lieut.-Col. J. C. Ross and Sir William Willcocks, in December, 1883. Mr. E. W. P. Foster and I followed in April, 1884, and Sir William Garstin, in October, 1885. With the retirement of Sir William Garstin next spring, there will remain nothing of this pioneer band in the Irrigation Service except the memory and the fruit of their labours.

As long ago as 1892, the year of Sir Colin Scott - Moncrieff's retirement, Lord Milner wrote thus of irrigation in Egypt under British direction:—" Viewed as a whole, there can be no question, that the Irrigation Department is, of all the branches of the Egyptian Service managed by British chiefs, the one upon

which, from first to last, it has been possible to look with the most unmixed pride."

And since that year to this, the Irrigation Department, under Sir William Garstin, has been earning fresh wreaths of laurels for victories no less renowned than those it won before.

DISCUSSION.

The CHAIRMAN (the Earl of Cromer) said he was sure that all present would fully agree with him in thinking that they were greatly indebted to the author for his most interesting and instructive paper. He desired to make one or two remarks upon a subject upon which the author had dwelt, namely, the abolition of the Corvée. Curiously enough only the previous day, in another place, he was speaking of the evils which had resulted from adopting the system of forced labour in another part of Africa, the unfortunate and misgoverned Congo, and he pointed out that in the face of great obstacles they had managed to keep clear of the system in Egypt. It could not be doubted that of all the administrative problems with which they had to deal that was the one which probably presented the greatest difficulty. Moreover, the difficulties were of a nature that could probably only have occurred in a country which Lord Milner had very aptly termed the land of paradox. When Sir Colin Scott-Moncrieff and his associates took the matter in hand the position was somewhat as follows: it was absolutely necessary to clear a certain amount of mud out of the canals in order to enable the water to flow freely over the fields. For centuries past the Egyptians had been accustomed to be flogged by various rulers, from Pharaohs to Pashas, in order to make them remove the mud. Suddenly Lord Dufferin stepped upon the scene and decreed that they were no longer to be flogged. He was quite right, but the situation that was created for the moment from the point of the English administrator was somewhat embarrassing, because the Egyptians were blind to their own interests. They said to themselves, "As we are not to be flogged, and, as we are not obliged to remove the mud, we will not remove it;" the result was that for the time being the Englishmen in the country were on the horns of a dilemma. It appeared for the moment as if they would be either obliged to let the Egyptians starve, or to flog them in order to save them from starvation. The scientific skill and patience of Sir Colin Scott-Moncrieff saved them from the adoption of either of those two unpleasant alternatives; but for the time being the crisis was very acute, and caused a great deal of anxiety. The author had referred to certain criticisms which Sir William Willcocks recently made upon the late Sir Benjamin Baker's work. Sir Benjamin Baker's reputation was not only very dear to those who, like himself, had the privilege of his personal acquaintance and friendship, but also to the nation in general. He was afraid that he (Lord Cromer) might be, in some respects, responsible for the mistake into which Sir William Willcocks, he did not doubt, quite unwittingly, fell, for in a despatch which he wrote to the Foreign Office, which was presented to Parliament, he said, using the loose phraseology of one who was not an expert, that the Assuan Dam was to be raised by seven metres: he ought to have said that the water-level was to be raised seven metres. He thought, however, that Sir William Willcocks, as an engineer, should have looked at what the other engineers said in the enclosures of the despatch, and if he had studied what the late Sir Benjamin Baker and Sir William Garstin said there could have been no misapprehension at all, because there it was stated that the water-level was to be raised by seven metres, and not the dam. He was glad that any misapprehension on the point had been completely removed. The work accomplished by the Irrigation Department had been very great, but it was as yet not nearly finished. He could not doubt that in the course of time the programme sketched out by Sir William Garstin in his epoch-making report would be eventually carried out. When that was done the whole of the waters of the Nile, from the lakes to the sea, would be under thorough control. One of the future problems reserved for the administrators of Egypt was how to find the money for carrying out those great works. He thought he was correct in saying that in the next 15 or 20 years some 20 millions of money might very advantageously be spent on irrigation in Egypt and the Sudan. In some respects the financial problem did not present any very great difficulty. It could not be doubted that the expenditure would be remunerative, and in regard to the manner of carrying it out, he did not doubt that the successors of Sir Colin Scott-Moncrieff and Sir William Garstin would perform their duties in a manner worthy of the traditions which had been handed down to them by their predecessors. The only difficulty which would be met by the administrators of Egypt in dealing with the financial problem was, that although the Egyptian Government had acquired full financial liberty of action in other matters, they had still not unlimited powers of borrowing. The matter was not very urgent, for there was a large sum of money now in the Egyptian Reserve Fund, and, moreover, in the course of a few years, what was known as the Domains Loan, the capital of which had now been reduced to one million, would be paid off, and the lands which would then remain over would constitute a valuable asset which might very possibly be turned to account. At the same time, the difficulty in connection with the continuing of these works—they could only be continued by borrowed money—would certainly have to be faced sooner or later. The late Lord Salisbury once said to him that when one reached the foot of the moun-

tains it was generally possible to find a pass through. He had the fullest confidence that Sir Eldon Gorst and his advisers would, when the proper time came, be able to find a pass through those particular financial mountains. Finally, he desired to say that the British engineers in Egypt had accomplished a task which, in the eyes of politicians, was even more remarkable than that of curbing and controlling the refractory waters of the Nile. They had justified Western ideas to Eastern minds; they had shown in a manner that had captivated the blurred intellect and wayward imagination of the poor Egyptian fellaheen, that the usurer and the vendor of adulterated drinks were not the only products of Christian civilisation. Inasmuch as they had done those things they deserved the credit of the civilised world, and more especially of all those who were interested in the solution of Eastern problems; they deserved the gratitude of the rulers of Algiers and Tunis equally with that of the rulers of India.

Sir Colin C. Scott-Moncrieff, K.C.S.I., K.C.M.G., said some very flattering and kind remarks had been made about him, both by the author and the Chairman, and he hardly knew which way to look. He was the first engineer to go from India to Egypt, where he had the benefit of the constant advice and help of the Consul-General, Sir Evelyn Baring. He was on good terms with the Ministers, and lived in a comfortable house in Cairo; in fact all the pleasant things seemed to come his way. But it was very different with the Inspectors, like his friend Sir Hanbury Brown who, in the cold and hot weather, had to perform their work in every part of Egypt. He remembered one of the Public Works Ministers telling him that Englishmen could not live out in the provinces, and he replied, "You try them; they have come from India." The Pasha still refused to allow them to go away from Cairo, and it was not until he threatened that he and his friends would go back to India that the Pasha gave way. The work Sir Hanbury Brown did was of an exceedingly hard character. He lived with his wife and family in a squalid Arab town 160 miles up the Nile for ten or eleven years. There were no other English ladies or gentlemen in the place, no doctor, and no civilisation of any sort. Again and again, the natives used to come to him (Sir Colin) with complaints about the unfair distribution of water, and on his reply that he would send a letter to the Governor of the Province about the matter, they always said: "Do not do that; send one of your Englishmen." He remembered one of the Ministers coming to him and saying that he had just come back from a visit to his estate, and that he (Sir Colin) would be glad to hear that the irrigation was going on well there. On his enquiring whether bribery existed at all, the Pasha replied that if a man took a bribe the Irrigation Inspector seemed to hear of it at once, and put a stop to it. He thought the people of the country liked the Irrigation Officers. There was a certain amount of pin-pricking, which the Chairman would recollect, from their French neighbours. There was a funny, little, spiteful newspaper, which used to tell astounding stories of what it cost the country to keep the Englishmen there. He remembered that one story was, that the Englishmen drew enormous sums for what they called "travelling expenses," not only for themselves, but for their "bool-dogs," for whom they also claimed travelling allowances. He recollected a French lady, a governess in the family of the Khedive's brother, asking him, on one occasion, to give the Khedive's brother another irrigation outlet in the particular canal where he had land. He (Sir Colin) knew that the Khedive's brother had at that time more outlets than he deserved and refused the application; but he chuckled inwardly to think that the Irrigation Officer so controlled matters that the Khedive's brother had to get his French governess to ask for irrigation facilities. The author had alluded to the kind of straw with which bricks were made in the early days. He, personally, remembered some very curious materials being used. The old gates at the Barrage were full of leaks, and it was difficult to hold the water up for irrigation purposes, although the engineer in charge tried all kinds of things. Close to the barrage there was an old palace belonging to one of the Khedives; nobody ever went there except rats, and bats, and moths. It possessed some splendid big rooms, with divans all round them, covered with smart French brocades, damasks, and silks, more or less worm-eaten. His friend, the engineer, saw them one day, and said they were the very things for blocking up the holes in the gates. Accordingly, the divans were stripped of their cushions, and silks, and brocades, the holes were blocked one after another, and the cotton crop was saved. He was sure the Khedive did not know what had happened, otherwise he would have had fits. It had been said that the finances of the country depended on the irrigation. In the same manner the irrigation depended on the finances, for without the money put at the disposal of the engineers very little could be done. There, again, the personal influence of the Consul-General helped them greatly. At the International Conference in London, in 1884, it was decided that the great Powers should guarantee a loan of eight millions sterling to Egypt. Lord Cromer asked that an extra million should be given, which should be devoted to the improvement of the irrigation works. He believed considerable doubt was expressed as to the expediency of supplying the money; but years afterwards the Secretary of the Treasury admitted to him that, although at the time he thought it was perfect madness, and that the money was being wasted, he had changed his mind, and Lord Cromer was right. Half a million was spent on the barrage, of which the author had given a description, although Sir Hanbury had not stated that it was he himself who designed and carried out the weirs below the barrages, which enabled the water to be held up from 13 feet to 20 feet. The other half-million was spent

on the improvement of various minor canals and the drainage of the country, which had been entirely neglected. Low-lying places had been left which had become salted and sour, and serious anxiety was felt by many people whether the land would not be permanently ruined. While he was in the country, rather more than a thousand miles of drains were constructed, which were about 5 feet wide at the top and enlarged to 50 feet near the sea. He believed much more had been done in that way since he left Egypt. But the work which he had most at heart in Egypt was the abolition of the Corvée, even more than the restoration of the barrage. Sir Auckland Colvin in his book said he (Sir Colin) preached the abolition of the Corvée in season and out of season, and probably Lord Cromer thought he had Corvée on the brain. The audience had heard what a monstrous system it was, and when he first went to Egypt he decided that the English engineers should not carry it on. From all time, the unfortunate fellaheen has accepted it as inevitable. He went to the Ministers and impressed upon them that there must be some change of system, and he was assured it was a well-known fact that the Egyptian fellaheen would not work for wages, and that he must be forced. Finding their efforts useless, the English engineers tried a little guile. They told the Pashas that they could not manage with the Corvée system, because the work was done so badly that the irrigation could not be improved, and if the benefits of irrigation were lost the revenue could not be obtained. After a great deal of delay they were allowed to introduce as a trial, into two provinces, the system of the redemption of the Corvée. They were allowed to tell the people that if they liked to pay a sum, which was practically six shillings, they might go home. He could not remember how much money was actually obtained the first year, but there happened to be a considerable fund that was available just then, and £116,000 was spent upon the redemption of the Corvée, including the six shillings per head per man. Subsequently £250,000 a year was spent for this purpose, an amount which was afterwards raised to £400,000 a year, a sum enough for the purpose, and since January, 1890, there had been no Corvée in Egypt. Those present could understand that it was a satisfaction to him to have been able to do even so little work in such a cause as that. The fellaheen now perfectly understood the difference between being forced to work and getting no pay, and being invited to work for pay. In conclusion, he again desired to thank his late chief, Lord Cromer, and his old colleague, Sir Hanbury Brown, for the kind way in which they had alluded to him.

Mr. MAURICE FITZMAURICE, C.M.G., said that in England a great deal was thought, and rightly thought, of the large works which supplied water to large towns, like Manchester, Liverpool, and Birmingham; but in those cases they were simply dealing with the supply of water for human beings and animals. It was a very different matter when engineers had to supply water for all purposes, including vegetation, in a country 600 or 700 miles long, which practically had no rain. During his four years in Egypt there were only three showers where he was working. The paper gave an interesting description of the great irrigation organisation of Egypt, but he was sure the author would say that unless an individual had spent some time in the country it was impossible to understand the vastness of the system. Even the ordinary visitor to Egypt who stood on the great bridge over the Nile at Cairo at Christmas and watched the great volume of the Nile running underneath could not judge what it meant to those engaged in the irrigation service, before the Nile Reservoir was working, when, in May, that great volume of water was reduced to about one-fifth or one-sixth of the volume then seen. Similarly it was difficult to imagine from photographs on the screen the enormous trouble connected with the works described. He had had the advantage of going over the Cairo Barrage with the author while the new weirs and other works were in progress, and learned many lessons from him in regard to the way of dealing with that most subtle enemy of engineers, water, if it was not a crime to call water an enemy in speaking of Egypt. When in 1900, a year of very low water, the author was standing on the Barrage, in Cairo, watching with great trepidation the gradual falling of the Nile, and caulking up the gates upon the two branches of the river with rags, he (Mr. Fitzmaurice) was 700 miles away, on the Nile, viewing with the greatest possible pleasure the falling of the river, because it enabled the engineers to accomplish in 12 months what in ordinary seasons would have taken three years; during that year nearly one-half of the Assuan Dam was built. Notwithstanding the low water in that year, the author, with his great care in the distribution of the water, obtained nearly a record cotton crop. He desired to associate himself with the remarks of the author respecting Sir William Willcocks's criticism of Sir Benjamin Baker. If the latter were alive he could afford to treat that criticism in silence. Dead, his reputation and memory remained untouched. At the same time those engineers who had worked with and under him felt indignant at such observations being made with reference to a man who for many years was the head of his profession; and he hoped that even at the present late hour Sir William Willcocks would take the only course open to him, by publicly expressing his regret for the remarks he had publicly made.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Sir Hanbury Brown for his valuable paper; and Sir STEUART COLVIN BAYLEY having in the name of the Council of the Society thanked Lord Cromer for presiding, the meeting terminated.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 11th, 1908; Sir Alexander Binnie, M.Inst.C.E., in the chair.

The following candidates were proposed for election as members of the Society:—

de Gruchy, Charles, Heathfield-lodge, Wandsworth-common, S.W.
Fighiera, Felix, 3A, Coleman-street, E.C.
Hill, Claude Hamilton Archer, C.I.E., The Residency, Udaipur, India.
Jones, Miss Constance Flood, 100, Grosvenor-road, S.W.
Leechman, George Barclay, 50, Campden-house-court, Kensington, W.
Lucas, T. Mackworth, F.S.S., 56, Moorgate-street, E.C., and Norton Lee, 169, East Dulwich-grove, S.E.
Mahmudabad, The Hon. Raja of (Ali Muhammad Khan), Mahmudabad District Sitapur, Oudh, India.
Pullen-Burry, Miss Bessie, 24, Prince's-square, Kensington-gardens, W.
Smith, Cyril, M.Inst.C.E., care of Herbert Allen, 31, Budge-row, E.C.
Tallberg, Professor Axel, A.R.E., Royal Academy of Arts, Stockholm, Sweden.

The following candidates were balloted for and duly elected members of the Society:—

Durham, Frank Rogers, A.M.I.C.E., 11, Orsett-terrace, W.
Heath, Charles Emanuel, 66, Herne-hill-road, Herne-hill, S.E.
Maxwell, Francis Taylor, Rochville, Connecticut, U.S.A.
Stephen, Miss Frances E. V., 48, Westmoreland-road, Westbourne-park, W.
Sykes, Miss Ella Constance, Elcombs, Lyndhurst, Hants.

The paper read was—

THE USE OF REINFORCED CONCRETE IN ENGINEERING AND ARCHITECTURAL CONSTRUCTION IN AMERICA.

By Ernest R. Matthews,
Assoc.M.Inst.C.E., F.R.S.E.,
Borough Engineer of Bridlington.

Introduction.

The term "Reinforced Concrete" refers to any approved concrete mixture reinforced by steel of any shape, the steel being inserted into the concrete in such a manner that the former will take up the tensional stresses and assist in the resistance to shear. The steel used for this purpose generally consists of one or a combination of the following:—Expanded metal, iron rods, with or without stirrups, joists, or straight or twisted steel bars.

Reinforced concrete has been more extensively used in engineering and architectural constructions in the United States of America than in any other country. It has been used for the former in connection with the construction of railways, bridges, retaining walls, dams, reservoirs, conduits, sewers, wharves, jetties, lighthouses, and a score of other engineering works; and its use in connection with building construction include the erection of all heavier structures, such as warehouses, factories, hotels, business premises, public buildings, &c. Its extensive use has been due to the fact that its strength, rigidity, durability, and fire-resisting properties have proved to be unsurpassed by any other material. Added to these good qualities is the fact that it is an economical material to use; and last, but not least, is the rapidity with which works can be executed where this material is employed.

It is the author's opinion that we are fast approaching the time when, as in America, so in this country, reinforced concrete will be the chief material used in all engineering and architectural constructions, and it is because of the increasing use of this material that he has put himself in communication with a large number of engineers in America, who have kindly supplied him with a great amount of valuable information on this important subject, and this he has embodied in this paper in the hope that it may prove both interesting and instructive to any who may be contemplating using this material in the erection of engineering or architectural works. Owing to the large scope of the paper the author is of course unable to go into minute details in respect to the works with which he is dealing, but the information which he has the pleasure of giving will no doubt be useful.

Reinforced Concrete in Engineering Works in America.

Municipal Engineering Works:—Under this heading the author proposes to deal with the use of reinforced concrete in the construction of waterworks, sewers, and sewage disposal works.

I.—*Waterworks.*

(*a*). *Reservoir Construction.*—In a paper which the author had the honour of reading before the Society of Engineers, in May last,

on "Waterworks Construction in America," he pointed out that many of the most modern covered service reservoirs in that country were constructed throughout of reinforced concrete, others which were built partially of this material. As an example of the latter he referred to the covered reservoir at Rockford, Illinois, U.S.A., a brief description of which is as follows:—The arched roof is constructed of reinforced concrete. The reservoir is 156 feet by 66 feet in size, and the roof consists of a ribbed arch; the ribs, which are placed 7 feet apart, increase in depth from crown to haunches. The arrangement of the reinforcement is clearly shown upon the section on the wall. The concrete used was 1 : 2 : 5, and the soffits were rendered over with cement mortar, composed of 1 Portland cement to $2\frac{1}{2}$ sand. The reservoir cost £3,778 6s. 2d., the roof costing £408 6s. 8d.

The roof of the covered reservoir at Louisville is also of reinforced concrete; this is one of the finest modern American covered reservoirs, and has a capacity of 25,000,000 gallons, the water area covered being 154,739 super. feet. The cost per square foot for covering this reservoir was 2s. 6d.

The author recently in an article in "Concrete and Constructural Engineering," entitled "Reinforced Concrete in Reservoir Construction," enumerated the advantages of using this material in reservoir construction, and stated that there were seven reasons why it should be used for this purpose:—

(1). More economical.—The roofs, walls and floors of reservoirs were of very much lighter construction if reinforced concrete was used, and were, therefore, more economical. For reservoir bottoms in bad ground it was much more reliable, and less costly than the ordinary method of construction.

(2). Cost of maintenance very low.—This was practically nil.

(3). Rapidity of execution.—Works constructed of reinforced concrete can be executed very rapidly.

(4). Hygienic value of reinforced concrete.—It will be generally agreed that this is very great.

(5). Saving of space.—By using reinforced concrete in the construction of a reservoir very much less material is used, and consequently less space occupied.

(6). Reservoir increases in strength with age.—This is a very important point, for while other materials deteriorate, concrete increases in strength with age.

(7). No joints.—A reservoir built entirely of concrete or reinforced concrete, or a combination of both, has no joints. To these seven advantages should be added an eighth which is of the greatest importance, *e.g.*, that a reservoir built of reinforced concrete is 14 to 15 per cent. cheaper (average) than one built of mass concrete or brick or a combination of both. These advantages the author considers have been fully realised by American engineers, and will account for the large use in that country of reinforced concrete in reservoir construction.

(*b*). *Aqueducts and Conduits.*—The same advantages apply equally to aqueducts and conduits constructed of this material. In a paper entitled "Reinforced Concrete Sewers and Conduits in the United States of America," presented to the Institution of Civil Engineers in 1906, the author dealt fully with this subject, and showed that there was a growing tendency in America to construct all aqueducts and conduits of reinforced concrete. He pointed out that the most important modern conduit in America, namely, the conduit built in 1903, in connection with the new water supply of Jersey city, was constructed of this material; it was elliptical in cross-section, 8 feet 6 inches by 8 feet 6 inches in size, and was nearly 4 miles in length. (*See* Fig. 1.)

The author stated that there were many important works of this character in America which were built entirely of this material.

(*c*). *Water Mains.*—The application of reinforced concrete to high-pressure water mains would have been thought a few years ago to have been a thing impossible, but so satisfactory has this material proved for this purpose, that there is every likelihood of it being used very considerably in the future. Much has to be said in its favour, the corrosion of the ordinary cast-iron water main and steel tubes is a serious matter, but in a reinforced concrete water main no corrosion can take place, hence the life of the pipes is very much longer. The joints in the reinforced concrete mains can be made equally as strong, if not stronger, than in the ordinary cast-iron mains. Most of the reinforced concrete water mains in America are of the "Bonna" system.

Quite recently a reinforced concrete water main, also of the "Bonna" type has been laid for the Swansea Corporation under the superintendence of the Waterworks Engineer, Mr. R. H. Wyrill, M.Inst.C.E., and this has

stood admirably the severe tests to which it has been subjected.

This main is designed for a working pressure equal to 185 feet head, but the pipes, which were taken at random, and tested in a proving press, Mr. Wyrill says stood a pressure equal to 450 feet head. The main has since its completion been tested up to a head of 382 feet, or over twice its ordinary working pressure. This work has been executed by an American firm of contractors.

The author understands that this is the first example of a reinforced concrete water main having been laid in this country, but there is every reason to believe that it will shortly be followed by other examples; in fact, a similar main is now being laid for the Norwich Corporation under the superintendence of the City Engineer, Mr. A. E. Collins, M.Inst.C.E.

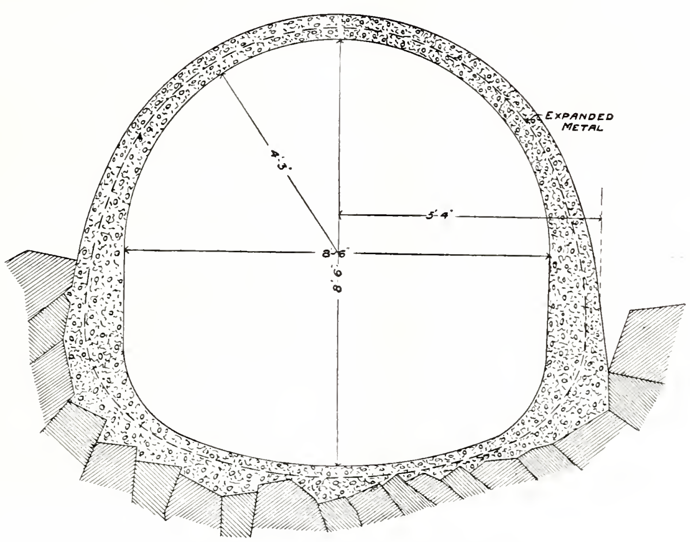
(*d*). *Dams.*—Several low-buttressed dams formed of reinforced concrete have been constructed in America. One of the most notable of these is the concrete steel dam at Theresa, New York. This is reinforced with Thacher rods and expanded metal. It is 120 feet long and 11 feet high.

Fig. 2 illustrates an economical design which American engineers have recommended for a dam of this class. It will be noticed that in this design reinforced concrete beams, of uniform cross section, but unequal spacing (owing to the greater pressure being exerted on the lower part of the dam) are introduced. The floor of this dam is of reinforced concrete only 4 inches in thickness.

II.—*Sewers and Sewage Disposal Works.*

(*a*). *Sewers.*—For the construction of large sewers the author does not know of a more suitable material than that now being considered, and most of the modern sewers in America are constructed of this material. Only one example, however, can here be given, that is a sewer of horse-shoe section constructed for the Lancaster, Pa., City Council. This sewer was designed by Mr. S. M. Gray, and will be seen in the diagram on the wall. It is reinforced by the insertion into the concrete of expanded metal, No. 10 gauge and 3 inch mesh.

Fig. 1.



(*b*). *Sewage Disposal Works.*—In sewage disposal works this material has been used very largely in America. For settling tanks, sewage reservoirs, and similar works, it has been found to be the best and cheapest material to use, the same advantages already enumerated for its use in reservoirs being applicable in this case also. Not only so, but as most of these works in America are constructed circular in plan, they are more easily constructed in concrete than in any other material.

III.—*Railway Engineering Works.*

(*a*). *Bridge Construction.*—American engineers have long since realised how eminently suitable this material is for this purpose, and have, therefore, employed it very largely in all classes of bridge construction. Many others while not constructing the entire structure in

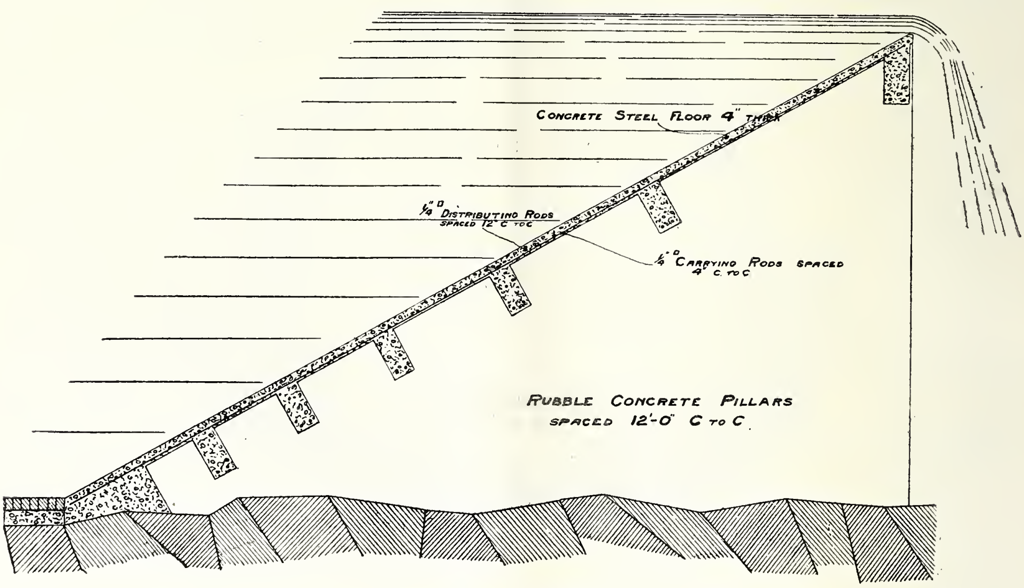
reinforced concrete, have used it extensively in foundations, floors, piers and parapet and spandril walls of bridges, while some have used it only for the arch ring.

Objection has been made by some engineers to the use of this material in the entire bridge on the grounds that a graceful structure cannot be erected if stone, brick, or steel or a combination of some or all these materials is not used. And the author is bound to agree that some of the earlier reinforced concrete bridges were strikingly plain and inartistic; nevertheless, this objection can now be dispensed with, as great improvements have been made in this direction, some of the more modern bridges of

Jefferson-street Reinforced Concrete Arch Bridge, Indiana, U.S.A.—The construction of this bridge was commenced in August, 1904. It spans the principal street on the east side of St. Joseph River. The design of the bridge is an elliptical arch formed of reinforced concrete, the reinforcement consisting of steel latticed ribs. The roadway of the bridge is 52 feet in width, the footways being each 10 feet wide. There are two electric-car tracks on the bridge. It is a skew bridge, and cost 119,000 dollars, the cost of piling being extra.

The piers and abutments are carried down into the clay, and about two feet of piling pro-

Fig. 2.



this type being very artistic in design.

The type of concrete-steel bridge which is most common in the United States is the arch type. Lightness in design and cheapness are the two chief recommendations of this bridge, while very long spans are obtained owing to the strength of this material. In Europe girder bridges of concrete-steel have been erected, but American engineers do not as a rule favour this type of construction. This material is also largely used in America in the construction of highway bridges and culverts, for which purpose it is very suitable.

As an example of the use of reinforced concrete in bridge construction in America, the author describes a highway bridge which has just been completed at Indiana, U.S.A. (Fig. 3.)

jects up into the concrete. The longitudina ribs are joined together by steel bars at the top and bottom chords of the steel arches, spaced a distance of 10 feet apart. The arches are plastered on top, and then coated with pitch. The concrete used in foundations was in the proportion of $8\frac{1}{2}$ to 1, that in the spandril walls $7\frac{1}{2}$ to 1, while that in the arch was 5 to 1. The bridge is faced with cement mortar, one inch in thickness, which was applied immediately after the concrete had been laid. The bridge was designed by Mr. A. J. Hammond, A.Am.Soc.C.E., who also supervised its construction.

One of the most important highway bridges constructed throughout of reinforced concrete, is that which has just been completed, and which spans the Hudson River at Sandy-hill, New York. This was designed by Professor

Wm. H. Burr. The total length of the bridge was 1,025 feet, width 35 feet 8 inches. It has 15 arch spans, each 60 feet in the clear, the piers are 6 feet thick at top, and 9 feet thick, 13 feet below the springing. The bridge was commenced in May, 1906, and completed in January, 1907. This interesting structure has been fully described by Professor Burr, in a paper which recently appeared in the "Proceedings" of the American Society of Civil Engineers (vol. 33, p. 394).

(*b*). *Railway Sleepers.*—The latest application of reinforced concrete to engineering work is its use in connection with the making of railway sleepers, for which purpose it is considered exceedingly satisfactory, its life being so very much longer than that of the ordinary timber sleeper which has been hitherto used. That it should be introduced for this purpose in America, where timber is so cheap, speaks greatly in its favour. These sleepers are now under investigation in the United States, and there is every reason to believe they will be recommended for use in the future.

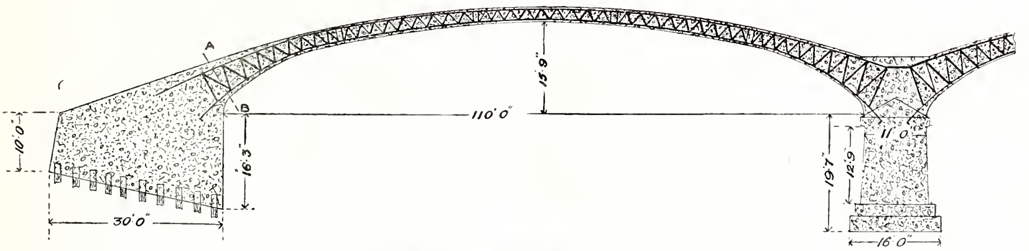
The ties in use are known as the Campbell, Percival, Buhrer, and Burbank ties respectively; a large number of these have been in use from eight to twelve months, and have proved very satisfactory. The description of these ties is briefly as follows:—

Campbell Tie.—This tie is approximately rectangular. At the rail seat there is embedded a flat grooved and shouldered tie-plate, which is $8\frac{1}{2}$ inches square. The reinforcement of the ties consists of two $2\frac{1}{4}$-inch wrought iron tubes (scrap boiler tubes), and an oval wrapping of wire. At the rail seats each pipe has a $\frac{1}{4}$-inch slot, 6 inches in length, cut in its side, and into this is inserted a sheet of heavy wire netting, 5 inches by $8\frac{1}{2}$ inches. The rails rest upon flat tie-plates, and are secured to same by means of $\frac{3}{4}$-inch U-bolts. A 15-16th inch cast washer, 4 inches by 2 and 5-16ths inch on top, is slipped over each end of the bolt, and held down upon the rail base by a nut. The size of the ties are as follows:—Length 8 feet 6 inches, depth 6 inches, width 7 inches, except that at the rail seat they are 10 inches wide. The concrete is composed of 1 : 2 : 3. The average weight of each tie is 356 lbs., which includes 35 lbs. of steel reinforcement, and the cost of the ties varies from 1·50 dol. to 1·75 dol. each. These ties have been severely tested in a Riehle testing machine, and did not fail until a crushing test of 80,000 lbs. had been applied. This test was applied at the rail seat.

Percival Tie.—This tie was invented by Mr. H. Percival, of Galveston, Tex. It is triangular in section for 4 feet at the middle, while the end portions have the sides more nearly vertical, and bottom rounded. The ties are 8 feet in length, $9\frac{1}{4}$ inches wide on top, and 10 inches deep, and are reinforced by means of $\frac{1}{2}$ inch corrugated steel bars (Johnson's patent), inserted in the top of each tie, and a single $\frac{3}{4}$ inch bar in the bottom. Triangular stirrups of 3-16 inch wire are placed over these at distances apart of 16 inches. Each tie weighs about 400 lbs., and the rails rest on a 2-inch wooden cushion, 9 inches by 14 inches. The fastenings consist of $\frac{3}{4}$ inch screw spikes, which enter sleeves or sockets inserted in the concrete.

Buhrer Tie.—This tie is the invention of Mr. C. Buhrer, Road-master of the Lake Shore and Michigan Southern Railway. It is re-inforced its whole length by means of inverted 65 lb. scrap rail. The flange forms the seat for the track rail and the attachment for the fastenings. The ties each weigh about 400 lbs.,

Fig. 3.

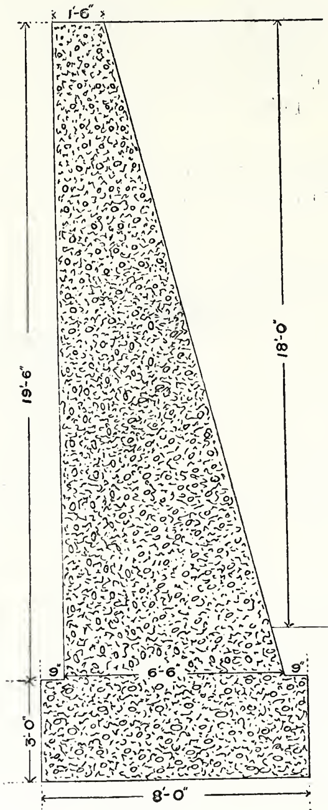


Section A.B.

which includes 165 lbs. of steel reinforcement, and most of the ties are formed of concrete composed of 1 to 4. There are 4,200 of these ties in use.

Burbank Cross Tie.—The figure on the wall illustrates what is known as the Burbank Cross Tie, as used since May, 1903, on the Hecla Belt Line Railway in Bay City, Michigan. In this tie the concrete is moulded around two metallic members.

Fig. 4.

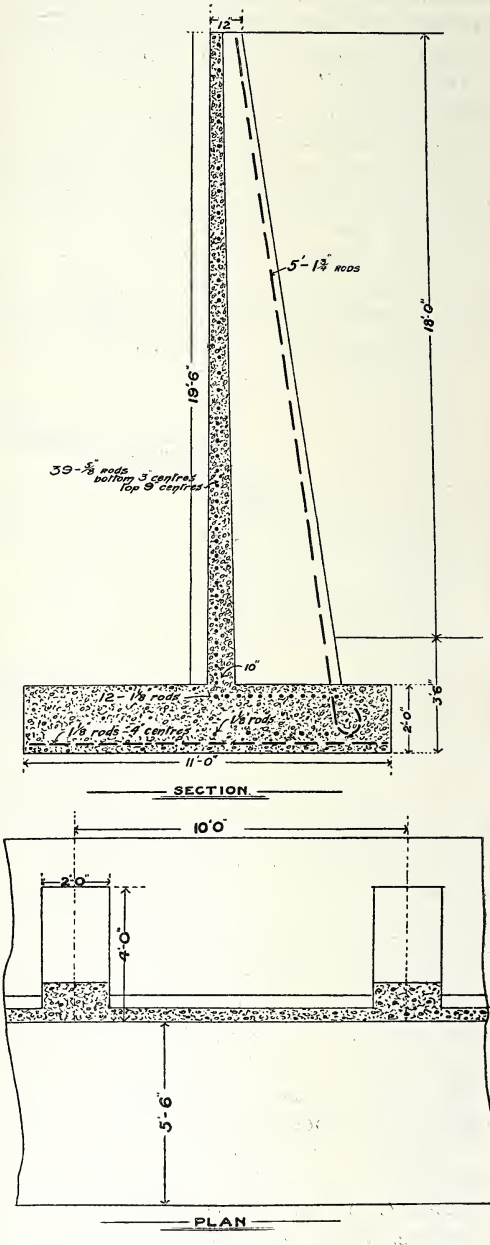


bers. These are flat bars, the uppermost of which is twisted. Wood blocks are partly embedded in the concrete underneath the rails. The ends of the top plate are carried over these blocks, and contained punched spike-holes. The end of the lower plate has four pins which assist in locking the plate into the concrete.

(c.) *Tunnels.*—Reinforced concrete has been used to very great advantage in America in connection with the construction of tunnels, and many interesting examples might be described, the author, however, has pleasure in describing one of the best known examples, namely, the Aspen Tunnel, Union Pacific R.R.

Aspen Tunnel, Union Pacific R.R.—This tunnel was constructed in 1901, it is 5,900 feet in length, and the excavation was through rock, a portion of which, 713 feet, was found to be very unstable, and in this length reinforced concrete was introduced in the construction of the tunnel. The

Fig. 5.



reinforcement consists of T beam ribs 12 inches in depth spaced 12 inches to 24 inches apart. The weight of the ribs was 35 lbs. per foot. They are connected together by means of riveted fish-plates, and cast-iron shoes are fixed at the ends of the ribs. The concrete used was in the proportion 1 : 3 : 6.

(*d*). *Retaining Walls.*—The author has already referred to the suitability of reinforced concrete for the construction of reservoir walls; the same advantages apply to retaining walls generally, for which purpose this material has been extensively used in America, and is admirably suited. Its chief advantages for work of this kind being:—

(1). It is more economical owing to the lighter section of wall which it is possible to adopt; a wall constructed of reinforced concrete has only about one-half of the material in it that a retaining wall of the usual design has.

(2). It occupies much less space for the before-named reason.

The author in Fig. 4 illustrates a cross-section through a retaining wall, 19 feet 6 inches in height, of the usual British design, and in Fig. 5 he shows a retaining wall of the same height, but constructed of reinforced concrete on the American principle. The reinforcement of the wall between the counterforts consists of $\frac{5}{8}$-inch rods spaced horizontally about 1 to $1\frac{1}{2}$ inches inside the face of the wall, and about 9 inches centre to centre at the top of wall and 3 inches centre to centre at bottom. $1\frac{1}{8}$-inch rods form the reinforcement of the base. The material required to construct 10 lineal feet of this wall with counterforts is 15·11 cubic yards of concrete, while the material necessary to build 10 lineal feet of the British type of retaining wall shown in Fig. 12 would be 37·77 cubic yards, the difference being 22·66 cubic yards. To add to the former wall there is, of course, the reinforcement, which in the 10 feet length of wall referred to would be 2,691 lbs. of rods.

IV.—*Harbour Engineering.*

(*a*). *Wharfs, Quays, and Jetties.*—Many examples might be given of the use of reinforced concrete in the construction of wharfs, quays, and jetties in America. This material is largely used for foundation piles, and very often for sheet piles also, which are driven between the main piles. It is also used in constructing the decking beams and slabs, for all these purposes its value is becoming more fully realised. The author will now briefly describe its use for the purposes named.

(1). Reinforced Concrete Piles. — Timber piles, for use in tidal waters, are fast becoming a thing of the past, the timber being subject to alternations of damp and dryness, lasts only a short time, and in waters infested with teredo, it is a well-known fact that timber piles are altogether unsuitable, and are rapidly becoming out-of-date. Cast-iron screw piles are also unsatisfactory, owing to the rapid corrosion of the metal.

In America, reinforced concrete piles for tidal work are being largely used, the two principal piles in use being the "Simplex" and "Raymond" piles; these the author describes later in this paper, when dealing with piled foundations for buildings.

In this country concrete-steel piles are now being used in the construction of groynes, for which purpose they are admirably suited. Messrs. Owens and Case are the patentees of these groynes, and they are likely to be used very largely in the future.

The Americans have not yet, however, used this material for this purpose.

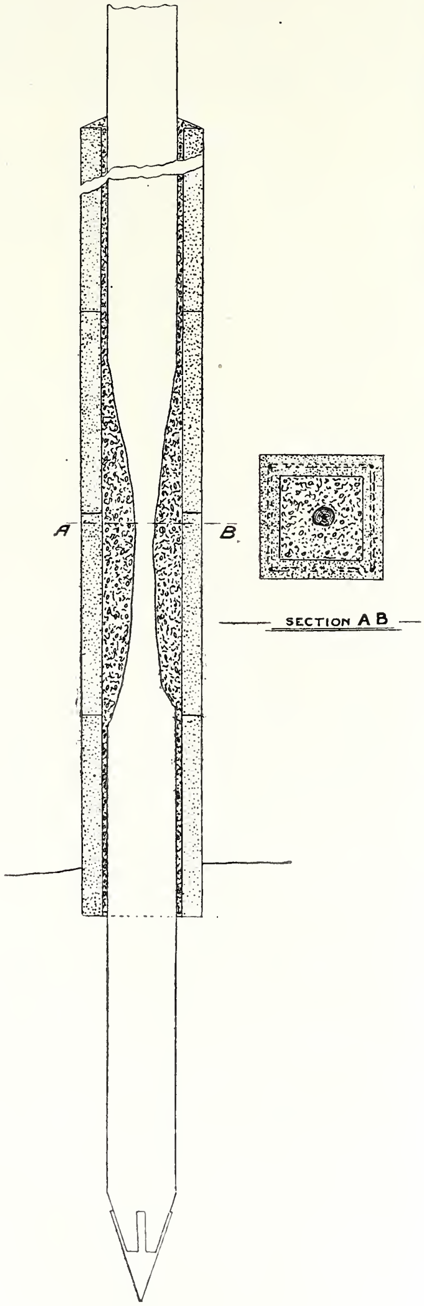
(2). Protection of Old Wooden and Iron Piles. — Not only has this material been largely used in the United States for new piles, but also in the protection and strengthening of old, and this applies to both old wooden and iron piles. It has been found to be a valuable material for a purpose of this kind. To remove and replace with new ones timber piles which are becoming decayed and worm eaten, or iron piles which are much corroded, is a serious expense; but by the use of reinforced concrete these piles can be strengthened without being removed. This has been done in a variety of ways, but the best-known method is similar to that adopted by Cubitt's Concrete Construction Company, which consists of casing the piles with concrete-steel slabs (see Fig. 6), and pouring inside the casing liquid grout. Some valuable work of this kind has been recently executed by the firm named at Southampton.

The method adopted by the State Harbour Commission, San Francisco, Cal., for protecting the timber piles of one of their piers which is in teredo-infested waters is shown in Fig. 7. The piles here are driven in groups of three. Wooden cylinders, formed of 3-inch sheet piles, were placed around each of these groups of piles, and driven 10 to 12 feet into the mud. The bottom of the cylinders were then sealed, and the mud pumped out. A cylinder of No. 16-gauge expanded metal was then put in position just six inches inside the timber casing, and the remaining space was filled with concrete, thus forming a reinforced-concrete pier. The wooden cylinder has been allowed to remain, but in time will be eaten away by the teredo.

(3). Decking Beams and Slabs.—These are

fully dealt with by the author under the heading of "Girders" and "Floors" in connection with the application of reinforced concrete to building construction.

Fig. 6.



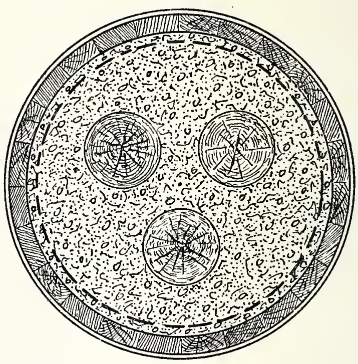
The method of construction of quays of this material in America is similar to that adopted in this country, one of the best-known examples of its use here being at Southampton, where a quay wall 400 feet long was built of reinforced concrete in 1898 for the London and South-Western Railway Company. The main or bearing piles were 12 inches by 12 inches, and spaced 3 feet 7 inches apart, the spaces between the piles in the front row being filled in with concrete-steel sheet piles. The whole structure is of the Hennibique construction, the reinforcement consisting of $1\frac{1}{8}$ inch bars, connected by 3-16 inch ties.

Reinforced Concrete in Building Construction in America.

There is not a city of any importance in America in which numerous examples of concrete-steel buildings may not be seen. It is considered by our friends across the Atlantic the most up-to-date method of construction.

As an addendum to this paper the author gives the regulations of the City of Chicago, issued in 1906, respecting the use of this

Fig. 7.



PLAN.

material in the construction of buildings, and, a perusal of these by the members of this Society will doubtless prove both interesting and instructive. In a paper read before the Incorporated Association of Municipal and County Engineers at their annual meeting held at Liverpool in June last, the author urged the necessity of the adoption of a similar code of building laws in the cities and boroughs of this country.

The author has used reinforced concrete for many purposes such as roofs, floors, foundations, &c., and he knows of no material to equal it. There are few buildings in this country that are constructed entirely of reinforced concrete, but in America many such may be seen. For example, the largest reinforced concrete building in the world is the Marlborough Blenheim Hotel, at Atlantic

City, N.J. This building, erected on the Kahn system of reinforcement combined with fire-proof hollow tiles, is 560 feet in length and 125 feet in width, the front wing of the building is 15 storeys high, the remainder of the building nine storeys. As an exhibition of rapid construction it is unsurpassed. The contract was signed in June, 1905, and the building was completed in eight months, including the decoration. It was erected by the National Fireproofiing Company, of New York, the architects being Messrs. Price and McLanahan, of Philadelphia. The building is absolutely fireproof, and is erected on a piled foundation.

The chief recommendations of this material for all classes of building construction are:—(*a*) Its fire-resisting properties; (*b*) its strength and rigidity; (*c*) its durability; (*d*) its cheapness. The author now briefly describes its use for the following purposes, viz., foundations, walls, floors, roofs, girders, columns, stairs, and tall chimneys.

(*a*). *Foundations.*—The author has proved from experience that where the foundations of a building are upon bad or doubtful ground reinforced concrete is eminently suitable. In America it is used most extensively in foundation work, and one or two examples of its use for purposes of this kind are given. Its use in foundation work will be dealt with under two headings:—

1. Spread Foundations.
2. Piled Foundations.

(1). Spread Foundations.—In the construction of most of the modern tall buildings of America, reinforced concrete forms the foundations. The author has used this material in the foundations (which were upon treacherous ground) of a chimney shaft, and he can testify as to its suitability for such a purpose.

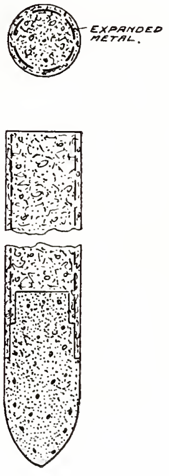
The foundations of Sprecles Building, San Francisco, which is a 19-storey building, were formed of reinforced concrete as follows:—

A continuous I beam grillage was formed the beams being 15 inches in section, and weighing 41 lbs. per lin. foot. The area of the foundations was 102 feet by 98 feet. Two feet of plain concrete was first put in, and upon this was set 15-inch beams. These were spliced end to end to a length of 96 feet. These having been put in position, the spaces between the beams were filled with concrete up to the level of the top of the beams, another layer of 15-inch beams laid at right angles to these was then set on top of the first layer, these were spliced similarly to the first ones, the spaces being filled in with concrete as before.

There are in America many other methods of using reinforced concrete in spread foundations. Expanded metal, and bar reinforcement is largely used for this purpose, but space will not permit of these being dealt with in this paper.

(2). Piled Foundations with Reinforced Concrete Caps.—Where piling in America is necessary, owing to the bad foundations met with, the piles used are often of timber (usually spruce), the heads of the piles being embedded in reinforced concrete, but the most up-to-date method of construction is to drive

Fig. 8.



reinforced concrete piles, and form the caps of the same material. The foundations of many tall buildings have been formed in this way, and it is undoubtedly the correct form of construction, its advantages being so clearly recognised that they need not be detailed.

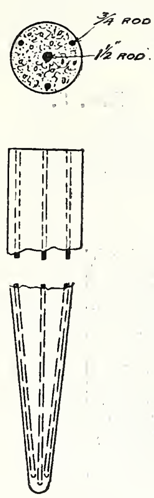
The two principal forms of concrete-steel piles used in America, as before stated, are the "Simplex" and "Raymond" piles, the former, illustrated in Fig. 8, being the invention of the Simplex Concrete Piling Company, of Philadelphia, Pa., the latter illustrated in Fig. 9 being invented in 1901 by the Raymond Concrete Pile Company, of Chicago, Ill. Both of these piles are built in place, the "Simplex" pile is reinforced by a circumferential cylinder of expanded metal 3-inch mesh and 5-16ths inch in thickness. This form of pile was used in the foundations of the Engineering School at Washington Barracks, Columbia, the size of the piles being 17 inches diameter and 35 feet long. The "Raymond" pile is reinforced by

three $\frac{3}{4}$-inch rods and one $1\frac{1}{2}$-inch rod, as shown in illustration.

These piles have each very much to be said in their favour. The building regulations of the various cities specify the maximum load allowable on each pile. This will be seen by reference to the addendum.

Reinforced concrete sheet-piles are also largely used in America, and these form a watertight barrier, capable of resisting any required pressure.

FIG. 9.



(*b*). *Walls*.—Reinforced concrete for the construction of walls of buildings in America has hitherto been confined, with a few exceptions, to what might be termed "low" buildings. Its use, however, in the near future in the construction of "tall" buildings is a certainty.

Captain Sewell, of the United States Army, in an article which recently appeared in "Concrete and Constructural Engineering," says :—

"It may be said that for buildings of moderate height and some importance, reinforced concrete seems sure to occupy the field to the exclusion of all other types of construction ; and it may eventually even drive out steel skeleton designs for very tall buildings, for already one sixteen-storey building has been erected in reinforced concrete, and the writer understands that one of eighteen storeys is under way in Cincinnati, Ohio."

The regulations (1906) of the City of Buffalo specify that the thickness of the reinforced concrete walls of a building shall be as follows .—Where there is a basement : If one storey, 8 inches ; if two storeys, 10 inches ; if three storeys, 12 inches. Where there is no basement :—If one storey, 6 inches ; if two storeys, 6 and 6 inches ; if three storeys, 8, 6 and 6 inches.

What an improvement is, therefore, effected in respect to additional space obtained by using reinforced concrete. Assuming, for example, that a warehouse is 70 feet in length, 33 feet in width, and has three storeys, each of which are 12 feet in height. It has no basement. The thickness of the walls, if of reinforced concrete, would be—first storey 8 inches, second 6 inches, third 6 inches ; but if the walls were built of brick, then, taking say the city of Birmingham regulations as being a fair example of our British regulations, these being up-to-date, the thickness of the longitudinal walls of the warehouse under consideration would be as follows :—First storey $22\frac{1}{2}$ inches thick, second storey 18 inches thick, third storey $13\frac{1}{2}$ inches thick ; the thickness of end walls would be—first storey 18 inches thick, second storey 18 inches thick, third storey $13\frac{1}{2}$ inches. By using reinforced concrete, under the American building regulations, there would be an increase of floor area on the ground floor of 227·48 sup. feet, made up as follows :—Floor area with reinforced concrete walls, 71′ 8″ by 35′ 5″ = 2537·48. Floor area with brick walls, 70′ 0″ by 33′ 0″, = 2310·00. Increase of floor area on ground floor, 227·48 sup. feet. An increase of floor area would occur on the first floor of 211·5 sup. feet, as follows :—Floor area with reinforced concrete walls, 72′ 0″ by 35′ 9″, = 2574·00. Floor area with brick walls, 70′ 0″ by 33′ 9″, 2362·50. Increase of floor area on first floor, 211·50 sup. feet. On the second floor there would be a saving in floor area of 133·13 sup. feet. Floor area with reinforced concrete walls, 72′ 0″ by 35′ 9″, = 2574·00. Floor area with brick walls, 70′ 9″ by 34′ 6″, 2440·87, a difference of 133·13. So that the total floor area saved by building the walls of reinforced concrete instead of brick would be 572 super. feet.

The nature of the reinforcement of walls is set out in detail in the Appendix, the regulations of the cities of Buffalo and Chicago going very fully into the methods of construction of walls of this class.

(*c*.) *Floors*.—Reinforced concrete has been used most extensively in America for the construction of floors, more particularly in warehouses, factories, hotels, and buildings of the heavier class, and it is admirably suited for this purpose, especially where a floor is subjected to vibrations of machinery.

Many forms of concrete-steel floor construc-

tion are in vogue in the United States; these might be dealt with under three classes :—

(1.) Arches with Flat Top.—This is a common form of construction; expanded metal is inserted in the arches as shown in diagram on the wall. This section represents the segmented arch floor of the St. Louis Expanded Metal Company.

(2.) Slab Floor.—This is another application of expanded metal to floor construction, and is adopted very largely; the slabs rest on girders, and the reinforcement is inserted on the under or tension side of the slab. The strength of slabs reinforced in this way is almost incredible, a floor of this kind often does not exceed in thickness three inches.

(3.) Ribbed Flat-plate Construction.—The best known floors of this class in America are those constructed on the system known as "Ransomes." The diagram on the wall illustrates such a floor constructed at the Pacific Coast Borax Company's Works, Constable Hook, N.J. The floor slab, which is in one piece; is four inches in thickness and is supported by concrete-steel beams, which are reinforced by means of upper and lower bars, which vary in diameter from half to $1\frac{1}{2}$ inch, together with stirrup bars at intervals. This floor was designed to support a load of 800 lbs. per square foot.

The modified De Vallière construction is similar to that just described, and is being looked upon with much favour in America. The floors of the gymnasium of the University of Pennsylvania, and of the Forrest Laundry at Philadelphia, Pa., are constructed on this principle.

A combination of hollow tiles and reinforced concrete joists instead of slabs has recently been introduced. The floors of the Marlborough Blenheim Hotel, already referred to, are constructed on this system, and as floors of this class are light, strong, and fireproof, they are likely to be adopted very largely, especially as they are a little cheaper than the ordinary concrete-steel floor.

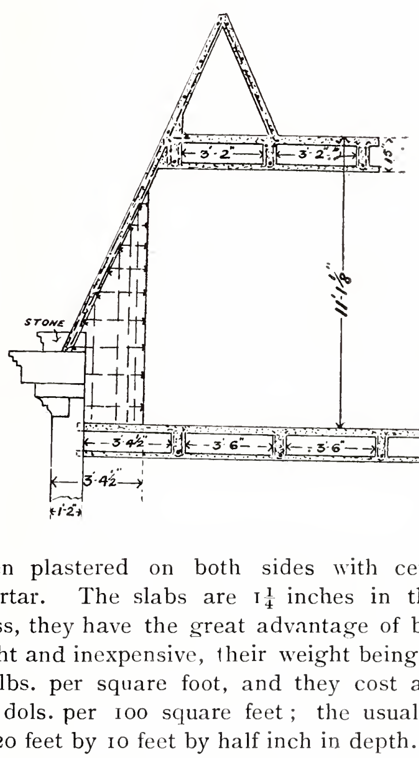
(*d*). *Roofs*.—The author has used reinforced concrete to very great advantage in roof construction, and has found it to be an excellent material for this purpose. In America it has been used very largely in work of this kind, in flat, pitched and arched roofs.

Two systems of concrete-steel roof construction prevail in the United States—(1). Roofing slabs. (2). Monolithic construction.

(1). Roofing Slabs.—The reinforcement employed in the construction of the flat roof of the Government Printing Office at Washington, was as follows:—Concrete-steel slabs, 12 feet in width, were made reaching from eaves to ridge, these were 5 inches in thickness, and moulded in place. The reinforcement consisted of a network of transverse and longitudinal twisted square bars. The joint at the ridge was filled with asphalt, and $\frac{3}{4}$-inch strips of pine were inserted in the joints between the slabs.

Reinforced roofing slabs are often made in another manner in America. The reinforcement consisted of corrugated steel sheets These are laid on the roof-framing and

FIG. 10.



then plastered on both sides with cement mortar. The slabs are $1\frac{1}{4}$ inches in thickness, they have the great advantage of being light and inexpensive, their weight being only 15 lbs. per square foot, and they cost about 21 dols. per 100 square feet; the usual size is 20 feet by 10 feet by half inch in depth.

(2.) Monolithic Construction.—Most of the systems of concrete-steel floor construction are also suitable for roof construction. Monolithic construction is greatly used in America, and in flat and pitched roofs the reinforcement usually consists of ribbed plates. As an example of roof construction the author describes a combined mansard and flat roof of a New York residence (see Fig. 10). The Hennebique system of reinforcement is here used, and the roof covering consists of asphalt bricks welded together. Domes and arched roofs are constructed in many ways, each system of reinforced concrete being considered by

the patentee to be the best, but a very well-tried system is that in which the reinforcement consists of quarter inch radial and circular twisted rods, as in the domed roof of the Court-house at Mineola, N.Y.

(*e.*) *Girders and Columns.* — Girders.— Reinforced concrete has been found to be well adapted for a use of this kind, and especially for long-span girders. Many interesting examples of its use for this purpose might be named, the author, however, refers to one only. This occurs in the New College of Music at Cincinnati, Ohio. In connection with the construction of this building it was found necessary to put in a girder 60 feet 7 inches span to carry the balcony, this girder was formed of reinforced-concrete, it was 12 inches wide and 32 inches deep, and was reinforced by means of eight $1\frac{3}{8}$ inch rods, and $\frac{3}{4}$ inch strap-iron stirrups. The concrete for the girder was 1 : 2 : 3 and 1 : 2 : 4.

(1.) Column Foundations.—The reinforced concrete foundations for columns in America resemble very much those for walls, and are shown in the diagram on the wall. The reinforcement consists of vertical rods which bear against one or more metal plates. Expanded metal sometimes takes the place of the rods and plates referred to.

(2.) Columns.—These, in the United States, have been usually built with longitudinal rods, with or without lateral ties. The latest practice, however, is to insert a circumferential reinforcement, and to place inside of this the longitudinal rods. It is the practice to mould the columns in place in vertical forms, this is sometimes done in sections, and at other times the whole column is built in one operation. The first method is preferable, as the concrete can be better rammed in. In the second method, long-handled rammers are often employed, while it frequently occurs that no ramming takes place at all, but a liquid concrete is used, and this is expected to fill the form in every part, and thoroughly surround the reinforcement.

A diagram on the wall represents a plan of the reinforced concrete column used in building the factory of the Central Felt and Paper Company, Long Island City, N.Y.

It will be noticed that the columns are 20 inches by 20 inches, and that the reinforcement consists of 3-16ths-inch hooping and four $1\frac{1}{4}$-inch vertical rods, circular in section, which were tied together at intervals.

The concrete was mixed in the proportions of 1 : 2 : 4. A number of smaller columns, 14 inches by 14 inches, were also inserted, and the reinforcement of these consisted of $\frac{3}{4}$-inch vertical rods.

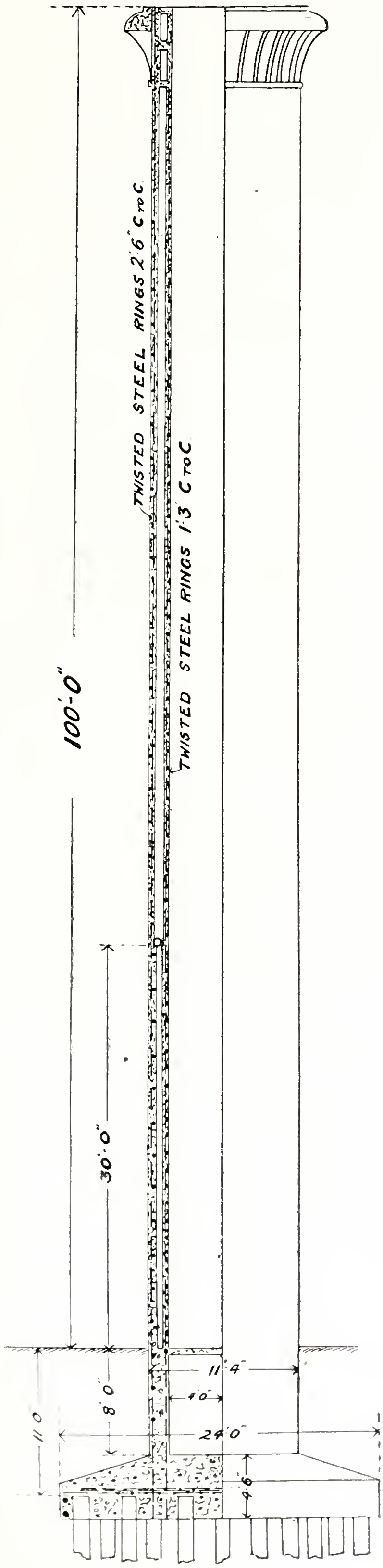
(*f*). *Stairs.* — For stair construction, reinforced concrete has been proved to be a valuable material. The author has used it for this purpose, and thinks very highly of it. There are two general methods in America of constructing stairs formed of this material. One is to construct the stairs of monolithic slabs of concrete, the under side of same being reinforced, the upper side being notched to form the treads and risers. In the other system, the treads and risers are reinforced as well as the under side of slab. As an example of the former method may be mentioned the reinforced concrete stairs of a New York residence.

As an example of the latter system, the author briefly describes the stairs of the sixteen-story Ingall's Building, Cincinnati, Ohio. These stairs consist of monolithic slabs, plain on the under side, and notched on top to form treads and risers. The slabs are reinforced by means of $\frac{1}{4}$-inch and $\frac{1}{2}$-inch rods, the former being inserted just under the treads, the latter on the underside of the slabs.

(*g.*) *Tall Chimney Construction.*—Most of the tall chimneys of factories, power stations, &c., in America are of steel-plate construction, and as the author recently pointed out in an article on the subject which appeared in the "Contract Journal," this form of construction has undoubtedly many advantages over brick shafts as usually employed, the following being some of its advantages :—(1) Costs only about one-half that of a brick shaft, (2) more stable, (3) absolutely proof against lightning, (4) occupies less space than brick shafts. Its disadvantages are that it is somewhat unsightly, and requires painting every three or four years. It has now, however, a new rival, namely, reinforced concrete, and several shafts formed of this material have already been erected, and have so far proved satisfactory. This form of chimney can be erected cheaper than brick but not so cheap as that of steel-plate construction. They possess one great advantage, however, over both of the others, and that is, that once erected they need no repairs and improve instead of deteriorate with age. As an example of this form of construction the author describes the reinforced concrete chimney of the Central Lard Co., Jersey City, N.J. (*see* Figs. 11, 12).

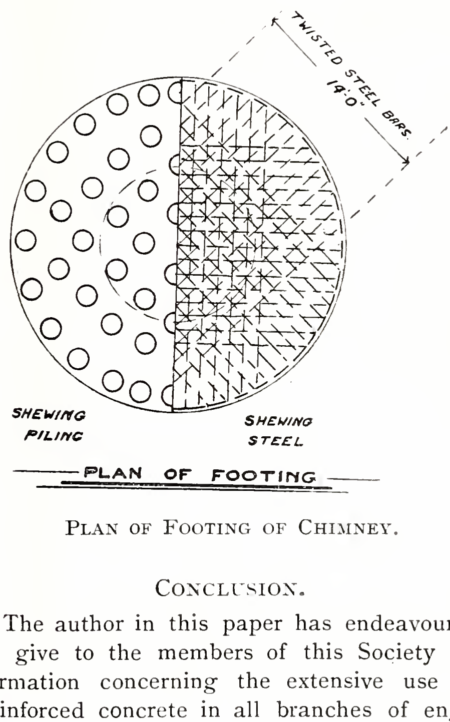
This chimney was designed and erected in 1901 by the Ransome Concrete Company of New York City. Its outside diameter is 11

Fig. 11.



feet 4 inches, the diameter of flue being 8 feet: the chimney is 108 feet in height. It has two shells, the inner one being 4 inches in thickness, the outer varying in thickness from 7 inches at the bottom of the shaft to 4 inches at the top. Vertical ribs or buttresses connect the inner and outer shells. The shells are formed of reinforced concrete, and the reinforcement consists of circumferential rings and vertical bars of twisted square steel. Twisted rods form the reinforcement of the foundations. Taking the weight of a cubic foot of concrete at 144 lbs., the total weight of the shaft is 362 tons. The chimney cost 3,500 dols.

Fig. 12.



Plan of Footing of Chimney.

Conclusion.

The author in this paper has endeavoured to give to the members of this Society information concerning the extensive use of reinforced concrete in all branches of engineering and architectural constructions in America, and to show that the use of this material is now extending to purposes for which only a short time ago it would have been thought altogether unsuitable. He trusts that the information given will prove both useful and interesting to the members of this Society.

In preparing his paper the author has obtained valuable information from that excellent engineering publication known as "Engineering News," to the editor of which paper he acknowledges his indebtedness; he is also greatly indebted to Mr. A. W. Buel, the author of that admirable American book,

published by *Engineering News*, entitled "Reinforced Concrete," which contains much useful information on this subject. He also wishes to express his gratitude to these gentlemen for the privilege of reproducing some of the illustrations accompanying this paper. He is also indebted to Mr. R. H. Wyrill, M.Inst.C.E., for useful information respecting the new reinforced concrete water mains at Swansea; to the publication known as "Concrete and Constructural Engineering;" to the city engineers of Buffalo and Chicago for copies of the building regulations in force in those cities; and to the numerous American engineers who have kindly supplied him with much valuable information on this subject.

APPENDIX.

Regulations of the City of Chicago, 1906, in respect of the use of Reinforced Concrete Construction.

The term "reinforced concrete," as used in this chapter, shall be understood to mean an approved concrete mixture, reinforced by steel of any shape, so combined that the steel will take up the tensional stresses and assist in the resistance to shear.

Stress.—Reinforced concrete construction shall be of such nature that the stresses can be calculated according to the accepted formulas of modern concrete engineering practice.

Permission to Erect.—Before permission to erect any reinforced concrete structure is issued, complete drawings and specifications shall be filed with the Commissioner of Buildings, showing all details of construction, the size and position of all reinforcing rods, stirrups, &c., and giving the composition of the concrete.

Concrete (mixing of, method of testing).—The concrete shall be mixed in the proportions of one cement, three of sand, and five of stone, gravel, or slag. The proportions shall be such that the resistance of the concrete to crushing shall not be less than 2,000 lbs. per square inch after hardening for twenty-eight days. The tests to determine this value shall be made by a competent engineer under the direction of the Commissioner of Buildings. The concrete used in reinforced concrete construction shall be what is usually known as a wet mixture.

Methods of Testing Cements.—Only high grade Portland cements shall be used in reinforced concrete construction. Such cements, when tested neat, shall, after one day in air develop a tensile strength of at least 200 pounds per square inch; and after one day in air and six days in water shall develop a tensile strength of at least 500 pounds per square inch; and after one day in air and twenty-seven days in water shall develop a tensile strength of at least 600 pounds per square inch. Other tests as to fineness, constancy of volume, &c., made in accordance with the standard method prescribed by the American Society of Civil Engineers' Committee, may, from time to time, be prescribed by the Commissioner of Buildings.

Sand, Stone, Steel.—The sand to be used in such concrete shall be clean, sharp, torpedo-sand, free from loam or dirt. The stone used in such concrete shall be clean crushed stone or gravel, or crushed blast furnace slag of a size that will pass through a three-quarters inch ring. The stone shall be fresh broken, and the gravel shall be thoroughly washed.

The steel used shall be calculated according to its elastic limit; for moving or vibrating loads a steel of a lower elastic limit than is used for quiescent loads shall be used.

Method of Reinforcing.—All reinforcing steel shall be completely enclosed by the concrete, and such steel shall nowhere be nearer to the surface of the concrete than the diameter of such reinforcing steel bar, or rod, or other shape. The steel in beams or girders shall be so disposed that there shall be not less than one and one-half times the thickness of the steel in concrete between the steel, and where more than two bars are used the bars shall be placed in two or more planes.

Reinforced concrete shall be so designed that the stresses in the concrete and the steel shall not exceed the following limits; extreme fibre stress on concrete in compression, five hundred pounds per square inch; shearing stress in concrete, seventy-five pounds per square inch; concrete in direct compression, three hundred and fifty pounds per square inch; tensile stress in steel, one-third of the elastic limit; shearing stress in steel, ten thousand pounds per square inch.

The adhesion of concrete to steel shall be assumed to be seventy-five pounds per square inch of surface where bars are three-quarters of an inch or less in diameter, and proportionately less for bars of a diameter greater than three-quarters of an inch.

The ratio of the moduli of elasticity of concrete and steel shall be taken as one to twelve.

The following assumption shall guide in the determination of the bending moments due to external forces; beams and girders shall be considered as simply supported at the ends, no allowance being made for continuous construction over supports. Floor plates, when constructed continuous, and when provided with reinforcements at top of plate over the supports, may be treated as continuous beams, the bending moment for uniformly distributed loads being taken at not less than WL divided by eight; the bending moment may be taken at WL divided by twenty in the case of square floor plates, which are reinforced in both directions and supported on all sides. The floor plates to the extent of not more than five times the width of any beam or girder may be taken as part of that beam or girder in computing its moment of resistance.

The moment of resistance of any reinforced concrete construction under transverse loads shall be determined by formulas based on the following assumptions:

(*a*). The bond between the concrete and steel is sufficient to make the two materials act together as a homogeneous solid.

(*b*). The strain in any fibre is directly proportionate to the distance of that fibre from the neutral axis.

(*c*). The modulus of elasticity of the concrete remains constant within the limits of the working stresses fixed in this chapter. From these assumptions it follows that the stress in any fibre is directly proportionate to the distance of that fibre from the neutral axis. The tensile strength of the concrete shall not be considered.

Construction — Reinforced Concrete.—Reinforced concrete construction shall be designed so that the shearing stresses, both vertical and horizontal, developed in any part of the construction, shall not exceed the safe working strength of the concrete, as fixed in this chapter, or a sufficient amount of steel shall be introduced in such a position that the deficiency in the resistance to shear is overcome. When the safe limit of adhesion between the concrete and steel is exceeded, some provision shall be made for transmitting the strength of the steel to the concrete.

Columns—Reinforced Concrete.—Reinforced concrete may be used for columns when the ratio of length to least side or diameter does not exceed twelve. The reinforcing rods shall be tied together at intervals of not more than the least side or diameter of the column, or spirally wound steel may be used. When vertical reinforcing rods are used in columns, such rods shall have their ends milled normal to the longitudinal axis, and such rods shall have full, perfect bearings at each joint, and such joints shall occur only at floors or other points of lateral support, and a tight-fitting sleeve shall be provided at all joints of vertical reinforcing rods.

Wind Pressure.—In the case of buildings in which allowances must be made for wind pressure as provided in Section 603 of this chapter, the reinforcing rods of columns shall be connected and the milled end surfaces shall be brought together by threading the rods and by threaded sleeve nuts, or threaded turnbuckles, or methods equally effective and satisfactory to the Commissioner of Buildings.

Tests to be Made by Contractor on Demand.—The contractor shall be prepared to make load tests on any portion of a reinforced concrete construction within a reasonable time after erection, as often as may be required by the Commissioner of Buildings. Such tests shall show that the construction will sustain a load of twice that for which it is designed, without any sign of failure, or in the case of beams, girders or floors, without deflecting more than one-seven-hundredths of the span.

Reinforced Concrete Walls.—Buildings of Classes I., II., III., VI., VII., having complete skeleton construction of steel or of reinforced concrete construction, or a combination of both, designed to safely resist all of the strains caused by the dead weights of the structure and of the live roads, and of the wind pressure within the safe limits of stress provided in this chapter for each material used, may have walls of reinforced concrete 6 inches thick for the upper two stories, and walls 7 inches thick for the two stories next below the upper two stories, and walls 8 inches thick for the stories next below the upper four stories, and walls 9 inches thick for the stories next below the upper six stories, and so on downwards, increasing the thickness of the walls 1 inch for each two stories, or part thereof. Provided, however, that such walls shall support only their own weight, and that such walls shall have steel rods three quarters of an inch in diameter, or of an equivalent area set vertically and spaced not more than 18 inches apart, and steel rods five-eighths of an inch in diameter, or of an equivalent area set horizontally tied to the vertical rod at each intersection with these, and set not to exceed 24 inches apart; and provided that where the weight of the walls of each storey is not transferred to the skeleton by spandril beams the vertical reinforcement shall be increased in weight in an arithmetical ratio of twice as much steel in the two stories next below the upper two stories, and three times as much steel in the two stories next below the upper four stories, and so on, downward. Vertical bars shall be spliced together by winding with iron wire. Horizontal bars shall be wired to the columns. Additional bars shall be set around openings, the verticals wired to the nearest horizontal bars, and the horizontal bars at top and bottom of openings shall be wired to the nearest vertical bars.

The steel rods shall be combined with the concrete and placed where the combination will develop the greatest strength, and the rods shall be staggered or placed and secured to the steel or reinforced concrete structural skeleton of the building, so as to resist a pressure of fifty pounds per square foot, either from the exterior or from the interior, on each and every square foot of each wall panel.

DISCUSSION.

The CHAIRMAN (Sir Alexander Binnie), in opening the discussion, said that after considerable study of the subject he had come to the general conclusion that in future the area in which reinforced concrete would make the greatest progress would be in architecture and not in engineering. The accusation was often brought against engineers that their buildings, however useful and stable they might be, were wanting in æsthetic proportions, and that, he was sorry to say, was very often true; but in looking at what their French colleagues had done in the way of reinforced concrete construction, he was sure it would be admitted that it offered opportunities for architectural and decorative effect equal to what could be produced in stone or brick. Residents in London must not run away with the idea that the Ritz Hotel was the *summum bonum* of what could be done in steel construction, because, however stable it was,

it did not please the artistic eye. That, however, was not the fault of the material with which it was constructed. A dwelling-house had to perform several important functions. First of all the walls had to be of sufficient strength to support the roof, the floors, and the material placed upon those floors, and that object could be gained by the use of reinforced concrete, with walls of exceeding thinness, compared with the older-fashioned brick or stone. There were great inconveniences, however, in living in a house with only 9-inch walls. He had lived in a hut built of very good 9-inch brickwork, but he wished it had been 18 inches, because such thin walls offered very little resistance to the passage of heat or cold through them during the summer or winter months. The present old stereotyped English building laws did not lend themselves to the mode of construction by reinforced concrete. If the admirable regulations of the City of New York could be introduced into this country by the municipalities an advance would undoubtedly be made in that kind of construction. The London County Council had essayed to introduce the same series of laws, but unfortunately the Bill was not passed. It was useless, moreover, for an engineer to go to a municipal body and say that large sums could be saved on the construction of buildings, but certain patent rights would have to be paid for. Municipalities would have nothing to do with patents, and it was the difficulty connected with patents which very largely prevented the further advance in the use of ferro-concrete at the present time. One patentee tried to evade the patent of another patentee until there were on the books of the Patent Office he did not know how many patents for doing exactly the same thing.

Dr. John S. Owens, in dealing with the question of the thickness of the walls, raised by the Chairman, said that in some tests he carried out in buildings, with brick walls, he ascertained that only 6 per cent. of the heat of the firing was to be detected in the air of the rooms, and that 50 per cent. must have gone through the walls. With a thin wall, made of reinforced concrete, the percentage would probably be very much higher. One advantage in the use of reinforced concrete, which had not been mentioned, was the absence of temperature cracks. He had had some experience in that respect in buildings and sewers, in connection with the latter of which it was difficult, with ordinary concrete, to prevent cracks. Ferro-concrete also had very great advantages for sea work, one of the chief being its high specific gravity. Several hundred feet of a groyne recently broke adrift on the Isle of Wight, and collided with the pier, causing some damage; but if a ferro-concrete structure was wrecked by the sea it would be impossible for it to cause any further injury. Ferro-concrete groynes were easily repaired, there being no difficulty in cutting out the injured part, boxing in the piles, and making the groyne absolutely sound. It was necessary, however, that any work put upon the foreshore should be thoroughly sound.

Mr. G. C. Reinhold thought it would be of interest if the author gave in his reply a few instances showing the principles which governed the distribution of the metal in the mass of the concrete.

Mr. C. S. Meik said he had been greatly struck with the very much more extensive use of reinforced concrete in America than in this country, and the same remark applied with even greater force to the continent of Europe, France in particular. As the Chairman had stated, the building regulations in this country prevented its use, while the Local Government Board regulations did not encourage it, the local authorities not being granted the same conditions for obtaining loans on works of that description as on works constructed of brick and masonry, which, viewed from a purely engineering point of view, was absurd. He was glad to hear it was extremely probable the Local Government Board would amend their regulations in that respect, and allow a longer period for the repayment of loans for work constructed in reinforced concrete. The conservatism of engineers in this country also retarded the use of the material, there still being a prejudice against its use, particularly in Westminster. Why that should be so it was difficult to see. It puzzled him to know why engineers should object to the use of steel and concrete combined, when they allowed its use in all shapes and forms individually. Possibly it was because it was something new and they were not accustomed to it. He lived in hopes that before many years it would be very much more used in engineering structures than at the present time. It was true that some failures of reinforced concrete work had been recorded, but he believed they were not due to the design or the method of manufacture, but to the fact that sufficient supervision had not been exercised in the manufacture of the material, and this was very necessary, because most of the men employed were labourers and not skilled artisans. He had been struck with the proportions of the cement in the concrete used in America. In the Rockfort Reservoir the proportions were 1 : 2 : 5; one cement, two sand, and five stone, *i.e.*, one of cement to seven of other ingredients. In this country engineers were accustomed to using much stronger materials, the proportion being about 1 : 4, a much stronger concrete being obtained. The materials used in the Rockfort Reservoir would stand an ultimate strain of about 3,000 lbs. per square inch, whereas by using 1 : 4 material it would stand 4,000 per square inch, equal to 33 per cent. greater strength, which was obtained at an additional cost for cement of $2\frac{1}{4}$d. per cubic foot; or $3\frac{3}{4}$ per cent., taking the cost of a cubic foot at 5s., and the extra strength obtained was well worth that. The weak point in all ferro-concrete structures, especially in beams, was the concrete. It was more easy to

calculate the strength of the steel put into structures than the concrete, owing to the fact that the concrete was made on the spot, and was not always subject to strict supervision. He did not agree with the author's remarks in regard to the rapidity of construction, and believed that, other circumstances being equal, it would be no quicker to build with ferro-concrete than with brick and other material. In America, however, work of any description was done very much more rapidly than in this country. He had used concrete piles very extensively, and had noticed no signs of deterioration in the steel inside the concrete. The piles were carefully made so that the water was excluded from contact with the steel, and there was no fear that the steel would not last as long as the concrete. He had recently had occasion to replace a timber pier in the Bay of Naples with ferro-concrete piles, the timber having been completely riddled by an insect similar to the teredo, but far more destructive, as it not only attacked timber, but was injurious to stone. Compared with bare iron, there could be no doubt that a concrete surface was much the better, because the former would deteriorate rapidly. With regard to the author's illustration of the preservation of timber piles at Southampton by slabs, he thought it was only a veneer. It was impossible to say what was going on inside; and unless a complete skin was made to the piles so as to exclude the water completely, they would ultimately decay. The method carried out at San Francisco was the one which should be adopted. The Institute of British Architects had issued some regulations for the use of the material which were very similar to the Chicago regulations, only they were a little more severe. He very much doubted whether the regulations would be a benefit as far as large engineering works were concerned, because they placed a limit upon the engineer—hard and fast rules were laid down beyond which he could not go. He was at the present time using reinforced concrete, and putting a considerably higher strain on it than the regulations allowed, simply because he was making the material stronger and providing for strict supervision during its manufacture.

Mr. H. Conradi enquired whether any practical tests had been made for the purpose of ascertaining how two such totally different materials as concrete and steel, in which the elongation and compression due to temperature were so different, acted. It appeared to him that each would act according to its own capacity.

Mr. F. Ruddle enquired whether in America anything was done for the purpose of protecting the steel, which was the agent upon which engineers depended so much for their strength. Steel corroded, and was affected by the atmosphere. A few details as to the component parts of the concrete would also be useful. A big building was being constructed in London at the present time with reinforced concrete, which was composed of crushed flint. In his opinion it would make the process expensive, and it would, therefore, be of interest if the author would state whether the materials ordinarily used for concrete, such as clean ballast, could be as efficiently employed as crushed flint.

Mr. Charles H. Colson thought the material itself was very excellent in its proper place, but it had its limitations. There were many forms of construction which reinforced concrete made possible, which would be otherwise impossible, but he thought engineers ought to deprecate its use for works in which it was not suitable. The strength of ferro-concrete entirely depended on the material of which it was made, and the material depended more than in any other manufacture on the workmanship put into it. Girders and steel for constructional purposes were made at factories under skilled supervision; but in the case of ferro-concrete, while the steel might be good the concrete was made on the works by more or less unskilled men. Another important point was that if water reached the steel, sooner or later rust would be caused, which meant that the structure would fail. In his own practice he had endeavoured to stop that action by coating the steel, as soon as it came on the works, with a fairly thick coating of Portland cement grout; and even in cases where the steel was slightly rusted, if it was covered with that coating, it would be found after a short time, if the grout was knocked ff, that the steel was quite clean. It seemed to him that one of the great uses of reinforced concrete was in piles, of which there were two descriptions, one being built before driven, and the other made in place. He could not help thinking that the pile made before it was driven, which was made with care, and in which the steel structure was put exactly where it was wanted, was, on the whole, the best. He had been rather interested in the use of ferro-concrete for pipes. He had made a number of experiments in trying to make concrete water-tight, and, although he had been successful, it seemed to him to be somewhat doubtful whether a skin of concrete three inches thick could be made really water-tight, so that the water would not reach the steel, and set up rust. Factory chimneys made of reinforced concrete possessed great advantages, being light in weight, comparatively small in first cost, and very rapid in speed of construction; but how long they would last was another question. Temperature cracks were found in such factory chimneys, and although they might have nothing to do with the steel inside, they necessarily made the constuctor anxious. There had been several failures in the United States of such chimneys, but they had been entirely due to bad workmanship. Ferro-concrete was practically out of the question for buildings in London, except for companies and other bodies, which were outside the scope of the Building Laws. Dwelling houses built

with ferro-concrete had the disadvantage that unless some special form of construction of the floors was adopted, not only were they cold, but they also transmitted sound to a great extent. Ferro-concrete could also be usefully and cheaply used for retaining walls in harbour work, where there was no weight, such as cranes, on the top. Where cranes had to be used, he thought the ordinarily built harbour wall had an advantage. There was one great use for reinforced concrete in the future which the author had mentioned, namely, dams.

Mr. W. Atkin Berry thought the failure of concrete in the instances which had been referred to was directly attributable to the character of the reinforcement. In some cases the section was simply a T iron, in which the amount of adhesion was small. Reinforced concrete had recently been used in the construction of caissons. They were made in short sections, such as could easily be handled with cranes, the first one having a cutting edge, the other sections being connected by cement. A previous speaker had suggested that piles should be made before being driven, but he omitted to consider the very important element of the damage which might occur to the piles in being moved, whereas, if they were made *in situ*, it was impossible for them to be damaged in any way. The chief criticism laid against concrete work was on the score of its ugliness. Some of the buildings were not so beautiful as they might have been, but many people seemed to forget that the most important effect to the eye was the line of the work and not the decoration. He could not understand why in the bye-laws of the City of Buffalo, the walls had to be made thicker for the lower storey, because the outside beams were made to carry all the load. It seemed an absurd regulation, because no allowance was made for a difference thickness where the height between the floors was greater. The author had stated that, in the Spreckles building in San Francisco, large H beams were used in the foundations. He desired to know if, when those foundations were designed, the beams were calculated to carry the whole of the load of the building, no notice being taken of the concrete in the calculation. If that was so, he thought the paper was rather misleading, because that could not be considered as reinforced concrete; the steel beams carried the whole of the work.

Mr. A. Bernard Geen thought the essence of the whole question was, whether the steel inside the concrete would deteriorate, and desired to know whether, by scientific research or experiment, a conclusion had been arrived at on that point. It was known that if steel was exposed to damp it corroded, and it was also known that concrete was not an absolute guard against the penetration of wet. In the construction of the concrete floors of buildings, for instance, the floors were saturated with wet, and it would be interesting to know what the effect of that was upon the steel in the building. He had heard that the method of coating the steel with cement grout to protect it from rust was not effectual, and he thought some guarantee on that point should be given. The difficulty of living in ferro-concrete houses, with walls only six inches thick, could be overcome, there being methods by which such buildings could be made habitable; and if that was the only complaint against them, it was of no avail.

Mr. Noble Twelvetrees said that reinforced concrete had not been in vogue for a sufficient number of years to ascertain what effect corrosion would have upon it, but it was possible to judge by samples of metal which had been embedded for many years in lime concrete, and there was abundant evidence to show that metal was preserved in that material. In the "Proceedings of the American Society of Civil Engineers" one of the speakers mentioned an instance of an iron ship, which 30 years previously had been cased inside with one or two inches of cement, and on it being chipped off on a subsequent occasion, the iron underneath was found perfectly preserved. In a similar manner he knew from personal experience that steel in some piles, driven at Southampton nine years ago, was found in an equally good condition. One speaker had referred to floors being saturated with water. Probably they were made of coke breeze, which was a material to be severely avoided for such purposes. In his opinion, it was not necessary to put grouting on the steel bars. They should be allowed to rust a little bit, if necessary, then put into the concrete, after which a chemical action took place. A ferride of calcium was formed, which was a substance more bulky than rust. Consequently there was a very good grip between the concrete and the steel, and the compound had the effect of preserving the steel from further corrosion. That was a fact which should be borne in mind by those who felt doubtful as to the durability of the material.

The Secretary announced that Mr. Carey, of 36, Victoria-street, Westminster, had written to say that he was building a pier of armoured concrete in the Thames, and that should any members like to see the work in progress, he would be most happy to arrange for them to do so, if they would communicate with him.

Mr. Matthews, in reply, desired to join issue with the Chairman when he said that the chief development of reinforced concrete in the future would be in the architectural, and not the engineering direction. Speaking as an engineer, he believed that reinforced concrete had a very great future before it not only in this, but in other countries. He did not think the objection the Chairman raised as to thin walls causing the rooms to be cold, could be urged as a disadvantage against reinforced concrete, because it could be

overcome in many ways. He agreed with Sir Alexander, however, that local authorities fought shy of having anything to do with patents, and that was no doubt an obstacle; but when engineers were able to carry out work without the intervention of any patentee, he believed that ferro-concrete would go ahead by leaps and bounds. He agreed with Dr. Owen's remarks with regard to the ease with which repairs to reservoirs and piles could be carried out. He could not definitely say when the first patent for reinforced concrete was taken out, but knew that the principle was in use on the Continent 40 years ago in the construction of sewers and conduits. Two reasons had been given why reinforced concrete had not been taken up in this country, firstly, that the building regulations would not allow of it being used; and, secondly, that the Local Government Board allowed such short loans for the work. It was possible to get a loan for 30 years for cast-iron water mains and timber structures, but only 15 years for reinforced concrete. There was room for much improvement in that respect. There was undoubtedly a great deal of reluctance on the part of engineers in this country to take the matter up, but he was thankful to say it was gradually passing away, and they were beginning to realise the great advantage of using such a material. In reply to Mr. Meik's remarks with regard to the proportions of the concrete, he desired to point out that in this country a 1 : 7 concrete would not be used for the walls and floor of a reservoir, 1 : 4 being the usual figure; but he agreed that it was an advantage to use better concrete, considering that the extra cost was so little. One of the most important points raised in the discussion was whether the steel deteriorated. Two years ago he had occasion to pull down part of a sea wall at Bridlington which was constructed 25 years ago; and was reinforced with steel chains. In many places the steel chains were laid bare, and he found there was no sign of corrosion, although the lower half of the wall had been practically covered by the sea at every tide. The most modern practice in America was to coat the steel with a cement wash; Prof. Charles L. Norton, of the Massachusetts Institute of Technology, Boston, having come to the conclusion, after carrying out a number of experiments in coating metal with different materials, that neat Portland cement, even in a thin layer, was an effective preventative of rusting. Seeing that the cost of coating a piece of metal was practically nil, he intended in any future work to have the metal coated in that way. It was a precaution, even if it was not absolutely necessary. In reply to Mr. Conradi's question, he knew that scores of investigations had been made as to the elongation of steel and concrete in reinforced concrete, and it had been proved that the two materials worked together satisfactorily. The modern practice, in regard to the component parts of the concrete, was to use ballast and sand, and it was very rare indeed that such a material as granite or stone, was mixed in the aggregate. He agreed to a certain extent with the remark which had been made that reinforced concrete was an excellent material, but that it had its limitations. He did not believe, however, that half the important uses to which it could be put had yet been discovered; and he fully believed that during the next 25 years it would be used for purposes which would alarm engineers, if it was so used at the present time. It had been said that piles built before they were driven were better than those built in place. There were advantages in both methods, but the lateness of the hour would not permit of his mentioning them. He believed reinforced concrete had a great future before it, even in water mains, because the ordinary cast iron main soon rusted, and unprotected steel tubes suffered in the same way. For chimney construction, dams, and caissons, it would also be most advantageous, but it should never be used unless there was the strictest supervision. He did not think it was necessary to pay much attention to the statements often made as to the ugliness of buildings constructed of reinforced concrete. If the buildings were in line and uniform in every part, they would pass every reasonable test in that respect. With regard to the Spreckley building, he did not know whether the girders were designed to carry the whole weight of the building, but it occurred to him that the foundations might have been constructed at a very much less cost. It was impossible to pass any judgment on the question of water coming through a floor made of reinforced concrete. If coke breeze was used, he could quite understand that the water would force its way up through the floor, and that the floor would be damp, owing to the porosity of the material used in the aggregate.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Matthews for his interesting paper.

THE LIGHTHOUSE ADMINISTRATION REPORT.

The Royal Commission on Lighthouse Administration have just issued their report, after an inquiry of about a year and a half. The terms of reference were, "To inquire into the existing system of management of the lights, buoys, and beacons on the coast of the United Kingdom by the three general lighthouse authorities, and as to the constitution and working of these authorities, and to report what changes, if any, are desirable in the present arrangements." It may be mentioned that, while the Board of Trade possesses the supreme authority over lighthouses, there are three "general" authorities and 425 local authorities, in addition to an Advisory Committee, a consultative body of recent creation, interposed between the Board of Trade and the three general authorities. The Trinity House is the most ancient and powerful of the

three bodies, and has certain control over the two Scotch and Irish Boards, which control, we may observe, the Royal Commission recommend should cease. The annual cost of these three bodies during the last seven years averaged £271,102, £92,642, and £117,389 respectively; but we are assured that comparison between the three is impossible owing to a variety of circumstances, chief among them being the high scale of remuneration assigned to the acting brethren of the Trinity House. The Royal Commission say they have not come across any financial abuses or administrative extravagance, and that, in regard to efficiency, there is a fairly general agreement that the coasts of the United Kingdom are as well and efficiently lighted as those of any other country. Thfs opinion, however, is not quite shared by Mr. Ennis, one of the Commissioners, in some "Reservations" published alongside of the report. He doubts whether the lighting of our coasts is equal to the lighting of the coasts of France, and adds that the west coasts of Scotland and Ireland are actually insufficiently lighted. This opinion is supported, in Mr. Ennis's long and interesting paper, by a number of statements and data which should, apparently, have been tested by cross-examination; as it is, they conflict with some of the main points in the report, which, however, makes no special reference to them. For instance, Mr. Ennis remarks that for every 16½ miles of coastline, France possesses 3 lights, and the United Kingdom 1; as regards electric lights, the French coastline has 13 powerful ones, and the United Kingdom only 6; there is no modern lightship of the advanced type on the coasts of the United Kingdom; and, speaking generally, Mr. Ennis remarks that the United Kingdom does not hold that front rank position with regard to the lights, buoys, and beacons on her coasts which her maritime supremacy and the enormous volume of her seaborne trade would appear to demand.

The principal recommendations of the Royal Commissioners are:—

(1.) The institution of a system of retirement with pensions for the acting elder brethren of the Trinity House.

(2.) The assignment of an elder brother of the Trinity House to act as assessor to the Scottish and Irish Boards respectively.

(3.) The setting up of a new Lighthouse Committee for the United Kingdom, in place of the existing Advisory Committee, but with a more established position and a wider scope of activity, to be composed of representatives of the Board of Trade, the Admiralty, the three general lighthouse authorities, shipowners, underwriters, and cargo-owners.

These are the main recommendations, but as regards (3), it is doubtful whether the Board of Trade will venture to sanction it in the face of Mr. Ennis's strong expression of disapproval of such a step. He holds that the original appointment of the Advisory Committee was an error of judgment (it was only a compromise with regard to the demand of shipowners for direct representation on the three general lighthouse authorities), and cites evidence to show the number of cases where the Board of Trade has felt compelled to disregard the opposition raised by the Advisory Committee to new Scottish lights. As the Royal Commissioners now propose to increase this power of objecting to the point of giving the new committee an absolute veto, Mr. Ennis considers this proposal specially objectionable. Mr. Ennis also formulates carefully-considered plans for re-constructing the three lighthouse authorities on a more truly representative and efficient basis, but these suggestions have not been adopted, and there is nothing in the report to show if they were considered by the Commissioners.

THE NORWEGIAN WOOD PULP INDUSTRY.

Both the wood pulp and paper manufacturing industries of Norway are in a flourishing condition. For a long time Norwegian wood pulp has played an important part in supplying the world's needs, while a considerable local demand has been met. Thus Norway's export of paper and products of paper amounted in 1906 to 97,413 tons, with a value of £908,000, while the quantity and value of exports of all kinds of wood pulp were as follows during the four years ended December 31, 1906:—1903, 447,744 tons, with a value of £1,374,000; 1904, 445,260 tons, £1,350,000; 1905, 442,325 tons, £1,535,000; and in 1906, 505,627 tons, valued at £1,776,000. The wood pulp exports in 1906 may be classified as follows:—Mechanical wood pulp, dry, 13,059 tons, and wet, 362,228 tons; chemical wood pulp, dry, 122,923 tons, and wet, 7,417 tons, a total of 505,627 tons. The principal countries to which these exports are sent are as follows, the names being given in their order of importance as countries importing this wood pulp:—The United Kingdom, France, Belgium, Holland, United States, Denmark, Germany, Spain, and Mexico. According to the American Consul at Bergen, the amount shipped to the United States was entirely dry chemical wood pulp. The principal countries competing with Norway in sales of pulp are Sweden, Finland, and Canada. The exports in 1906 of wood pulp and cellulose from Sweden was 414,811 tons, and from Finland, 56,181 tons. The price of pulp has, in the course of years, fluctuated a great deal. For example, the price of dry mechanical pulp in 1869, 1870, and a part of 1871 was about £8 per ton; in 1891, the value of a ton was £1 11s., which price was ruinous to the manufacturer. The first Norwegian pulp mill was established in 1863. There are now 72 factories, 53 for the manufacture of mechanical pulp, and 19 for chemical pulp. Wages of persons employed in the pulp mills and paper factories were estimated at £420,000 in 1906. All of the machinery used in the manufacture of mechanical wood pulp, and almost all of that used in the manufacture of chemical wood

pulp, is made in Norway. One factory uses in the manufacture of cellulose quantities of Norwegian pyrites. It is calculated that the proprietors of the forests received about £1,000,000 in 1906 for wood used in the pulp industry. The development of the Norwegian pulp industry has been rapid, and, although about 20 per cent. of the area of Norway is covered by forests, it is feared that if the consumption of wood continues at the present rate it will be only a matter of a very short time before the forests are depleted. The price of logs has almost doubled since 1870. It has been estimated, however, that the present national consumption of wood is not so great as formerly, owing—so it has been said by the superintendent of Norwegian forests—to its high price. The Norwegian Government plants about 1,500,000 trees in the forests each year, and in addition much good work is done by individuals and societies interested in the maintenance and improvement of forests. The Norwegian Forest Society has since 1901 planted about 30,000,000 trees, and cultivated or prepared large tracts of land. The Norwegian Störthing for many years has voted sums of money to this society, which receives similar assistance from the Norwegian wood pulp and cellulose manufacturers, the association of lumber exporters, lumber merchants, and proprietors of forests.

HOP CULTIVATION IN AMERICA.

The very risky character of hop cultivation has not only prevented the extension of hop cultivation in England, it is slowly contracting it. The possible profits are, in the cultivators' opinion, inadequate to the risks. It would seem to be much the same in some parts of the United States. In an interesting report on the agriculture of the States of Oregon, Washington, and Idaho (Cd. 3727-16), Mr. Consul Laidlaw says, that for some years past there has been a steady increase in the growth and production of hops in Oregon, which has now become the principal hop-growing State in the Union. There was an increasing acreage in bearing, and conditions were favourable until the middle of September, when picking was in progress. At that time heavy rains caused some damage and reduced the yield. As near as can be ascertained there were 25,000 acres in bearing in the State, which produced 158,655 bales of 185 lbs., and Washington had about 17,000 acres under hops, the product being 51,000 bales. Growers who sold their hops ahead made good profits, but a large portion of the yield was sold at prices leaving little or no profit, and in May of this year hops were selling below the actual cost of growing. Baled hops cost the grower 4d. to 4½d. per lb., and some qualities had to be sold under 3½d. In consequence of their experience during the past two years some growers, says Mr. Consul Laidlaw, are ploughing up their fields. Being subject to such violent fluctuations the hop crop is not a safe one for a farmer to depend upon entirely.

ARTS AND CRAFTS.

The Arts and Crafts Movement, and Girls' Schools.—The exhibition which has just been held in the temporary buildings attached to the museum at South Kensington, is perhaps one of the most striking proofs that could be given of the strides that have been made by the Arts and Crafts movement in the last fifteen or twenty years. It was described as "An Exhibition of Drawings and Works of Art," from the schools of the Girls' Public Day School Trust—and the exhibits gave, therefore, a very fair idea of what is being done in the way of drawing teaching in secondary schools for girls, not only in London but also in various large provincial towns all over the country. Not so very many years ago, the works shown would have been practically confined to drawings, and to paintings of flowers and still life, with perhaps a landscape sketch here and there. To-day, in nearly all the schools, some design teaching is given. Most of them send up designs executed by the students, while not a few go still further, and show works executed in stencilling, embroidery, leather, or whatever it may be.

This would seem to show that educational authorities realise the importance of arts and crafts much more fully than they used to do—and that it is assumed by the teachers in secondary schools for girls that a certain proportion of their pupils will take up some kind of craft work later in life, either as a hobby, or as a serious profession. It is, of course, a fact that many a girl who would some years back have taken a few singing or painting lessons after she left school, goes in nowadays for needlework, leather-work, woodcarving, or perhaps bookbinding, any of which she is only too ready to believe that she can learn in ten lessons. It is also true that a goodly number of well-educated girls are devoting themselves to various crafts more earnestly, while some, though not so many as the casual observer might suppose, are really earning their living at them. Since, then, craft work, whether as a recreation or as an occupation in life, has come to be looked upon as an employment for women, it is well that when girls are at school some part of their drawing teaching should be of a kind which will be of practical use to them when they take up a craft.

Design Teaching in Girls' Secondary Schools.—The usual practice in the schools seems to be to turn the drawing lessons in the direction of design for a year—say when the students are about 15 years old—and after that to carry them to some quite different kind of drawing. It is naturally difficult to differentiate the work of large classes, but the drawing classes in the upper parts of these schools are not generally very big, and it seems rather a pity that the people who do well in the design year should not carry that kind of work further next year, instead of taking up something quite different. Of course, in the limited time allowed for drawing or art teaching, it is not usually possible to do very much practical work, and

there is, naturally enough, a desire on the part of both teachers and pupils to make as big a show as possible in the time—but it is surely a mistake to encourage schoolgirls to stencil or paint patterns or floral sprigs on bags, &c., and then to outline the pattern with rough embroidery in coarse cotton or silk. If they descend to that kind of thing later on it cannot be helped, but they should not be allowed to do it in school. Stencilling and stencil cutting are admirable exercises in their way, and they seem to be well taught in some of the schools, but the girls should be shown not merely how to stencil but the proper use of the process. As it is they often abuse it.

Another direction in which improvement might easily be made is the lettering. In most of the schools the girls appear to be encouraged to make time tables, calendars, &c., to go on the notice boards of their class-rooms or of the hall. It would seem only natural that, since lettering must necessarily form so important a part of this kind of work, some trouble should be taken to teach at least a good simple alphabet and a legible set of numerals. It is all very well to do clever little sketches for the top and bottom of a calendar, or to illuminate a time-table with great elaboration; but if the letters and numerals, which are, after all, the *raison d'être* of the whole thing, are poor and niggling, the general effect cannot possibly be really satisfactory. One school has evidently tried the experiment of giving a few lessons in lettering, and it would be a good thing if the others would follow suit. The ability to letter neatly and well is an accomplishment which comes in very usefully in after life, and one which ought to be well within the powers of most people if only they were taught it with a little care.

The work of the schools is, on the whole, unpretentious enough, and there are very few instances of people who have labelled their somewhat elementary efforts, as wall-paper designs, and so forth. It is always easy to pick holes, especially in a system which is not far beyond its infancy. It may seem simple enough to suggest changes or improvements in the method of procedure. But there are two facts which have to be borne in mind in dealing with schools of this type—that the time available for drawing is usually very limited, and that this elementary design teaching is given by the ordinary drawing teachers, who have not necessarily had much training in design themselves, and who cannot be expected to be so well qualified in that respect as in other branches of their subject. It must be admitted that, in spite of these difficulties, a good deal has been accomplished. The girls are evidently being taught that there is such a thing as design, that patterns are not constructed hap-hazard, but on certain recognised and recognisable plans, and that in the case of floral designs, the natural forms have to be conventionalised and treated. This is, perhaps, as much as the ordinary secondary school can be expected to do in this direction, and a student who possesses this elementary knowledge, though she should not be encouraged to think that she can in consequence design, has a solid foundation for the further studies necessary to that end.

Book Wrappers.—Things move rapidly nowadays, and it is only natural that those which are more or less in the nature of advertisements should move most quickly of all. It is, therefore, perhaps not to be wondered at that paper wrappers—the covers of sixpenny novels and of weekly and monthly magazines should change at a pace which is altogether unprecedented. It used to be the regular thing for a periodical to use one cover design for the term of its natural life—but this now holds good as a rule only for the more serious publications. It is really quite difficult to keep pace with the changes in the wrappers of some of the popular illustrated magazines. The sixpenny novel, too, appears in many more guises than of yore. It used to bear upon its front page a glaring coloured picture usually so hastily printed that the blocks did not by a long way register—and the alternative to this was a tinted cover (very often of a rather colourless pinkish shade) adorned with a small woodcut. It was a surprise and somewhat of a shock when (a good many years ago now) one well-known publishing firm took to issuing its sixpenny publications in an attractive blue wrapper with a well-spaced and well-considered title.

It seemed at one time as though ingrained paper was going to take its place permanently amongst the covering materials for cheap books, but at present its use is almost confined, oddly enough, to rather serious publications and to advertisement booklets.

To-day, amidst countless variations, there are three principal and fairly well marked types of wrappers in use for sixpenny books. First comes the boldly pictorial type, which seems to model itself more and more on the modern poster. It is usually flat in treatment, and printed simply on a few flat colours, though there are a few exceptions to this tendency in book wrappers as there are in posters. In the second type the lettering is the most important feature in the design; in fact, it may almost be said to be the design. It is very satisfactory to note how much these covers have improved recently. The lettering, which used generally to be poor and thin, has been getting rapidly better, and is now often quite adequate to its purpose. A great deal more care is taken, too, than was formerly the case in choosing the colouring both of the lettering and of the ground. The third and newest type of wrapper is made of parchment, a material which is not quite so unsuitable to smoky towns as it would at first sight appear, since the surface does not hold the dirt. Some of the earlier parchment wrappers were on booklets intended primarily for Christmas presents, and were more or less heavily printed in colours. At present the two most widely circulated series issued in parchment—produced, by the way, by quite different firms—are printed in two colours only, and rely for their attractiveness entirely on lettering and pure ornament. Now that magazine covers of the ornamental type

have almost entirely disappeared, it will be interesting to see whether such designs will yet have some vogue on the wrappers of sixpenny books.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 18.—"Impressionist Painting: its Genesis and Development." By WYNFORD DEWHURST, R.B.A. The EARL OF PLYMOUTH, C.B., will preside.

MARCH 25.—"Recent Improvements in Decorators' Materials." By A. S. JENNINGS. SIR WILLIAM EMERSON, Past President R.I.B.A., will preside.

APRIL 1.—"Dr. Schlick's Gyroscopic Apparatus for Preventing Ships from Rolling." By M. WURL. SIR WILLIAM HENRY WHITE, K.C.B., F.R.S., will preside.

APRIL 8.—"Technical Education in America." By SIR WILLIAM H. PREECE, K.C.B., F.R.S.

APRIL 29.—"Modern Roumania." By ALFRED STEAD, Consul-General for Roumania. SIR PERCY SANDERSON, K.C.M.G., will preside.

MAY 6.—"The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE.

MAY 13.—

MAY 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. MARTIN DUNCAN.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MARCH 24.—"The Mineral Resources of Western Australia." By the HON. C. H. RASON, Agent-General for Western Australia. ADMIRAL SIR FREDERICK G. D. BEDFORD, G.C.B., Governor of Western Australia, will preside.

APRIL 7.—"The Imperial Problem of Asiatic Immigration." By RICHARD JEBB.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock:—

MARCH 31.—"Enamel Portraits." By CYRIL DAVENPORT, F.S.A. SIR HUBERT VON HERKOMER, C.V.O., R.A., will preside.

APRIL 28.—"Lace as a Modern Industry." By Miss ISEMONGER. ALAN S. COLE, C.B., will preside.

MAY 26.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." Four Lectures.

LECTURE II.—MARCH 16.—The fuel supplies of the world—The uses of fuel and the past demand—The existing supplies and the future—The necessity for immediate economy, and the lines on which it is possible—The calorific value of our fuels, and the amount utilised in practice—Fitting fuel to the work it has to do.

LECTURE III.—MARCH 23.—The smoke problem—Bituminous coal unfitted for any fuel purpose——Smokeless fuels—The question of high *versus* low temperature carbonisation in the manufacture of illuminating gas—The gas industry and its work in the future.

LECTURE IV.—MARCH 30.—The internal combustion engine *versus* steam—Gaseous fuel and power production—The utilisation of peat—The regeneration of Sun energy when our present fuel supplies are exhausted—Alcohol as a fuel, and its possibilities.

WILLIAM BURTON, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.

May 4, 11, 18.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

Tuesday and Friday evenings, at 8 o'clock:—

MARCH 17 (Tuesday).—"Child Workers and Wage Earners." By MISS NETTIE ADLER, Hon. Secretary to the Committee on Wage Earning Children.

MAY 15 (Friday).—"The Dangers of Coal Dust, and their Prevention." By W. E. GARFORTH, President of the Colliery Proprietors' Association of Great Britain.

HOWARD LECTURES.

Thursday evenings, at 8 o'clock:—

H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

LECTURE I.—MARCH 19.—The atmosphere in its relation to the bodies supported by it—Characteristic features of disturbances in the atmosphere in regard to direction, pressure, and velocity—Methods by which movement through, and stability in, the air, whether

in a steady or unsteady state, may be effected—Available motive power and propelling mechanism.

Lecture II.—March 26.—Navigable aerial contrivances in which the force of gravitation is opposed by means of floatation, *i.e.*, dirigible balloons—General theory—The balloon as a structure—Structural design of the framework—The form, construction, and pressure regulation of the containing envelope—Horizontal and vertical steering—A comparison of the balloons, Meusnier, Dupuy de Lome, Renard and Krebs, Gifard, Wolfert, Santos Dumont, Zeppelin, Lebaudy, Parseval, Barton, De la Vaulx, Nulli Secundus.

Lecture III.—April 2.—Contrivances in which the force of gravity is opposed dynamically—The methods adopted in nature—Birds, flying reptiles, flying animals, and flying fish—The stability and resistance of an aeroplane—Kites, parachutes, and the gliders of Lilienthal, Pilcher, Chanute, and the Wright Brothers—Lessons to be learnt from the use of models—Comparative features of the flying machines of Santos Dumont, Delagrange, Bleriot, and Farman, and others.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 16...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Vivian B. Lewes, "Fuel and its Future." (Lecture II.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. J. Blane, "A Modern Asylum—Bangour Village, near Edinburgh."

Victoria Institute, 8, Adelphi-terrace, W.C., $4\frac{1}{2}$ p.m. Rev. Chancellor J. J. Lias, "On the Decay of Ultra-Montanism, from a Historical Point of View."

Entomological, 11, Chandos-street, W., 8 p.m.

Tuesday, March 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Shaw Lecture on Industrial Hygiene.) Miss Nettie Adler, "Child Workers and Wage Earners."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Stirling, "Membranes: their Structure, Uses, and Products." (Lecture VI.)

African, United Service Institution, Whitehall, S.W., $8\frac{1}{2}$ p.m. Colonel David Bruce, "Sleepiag Sickness."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. William Barclay Parson's paper, "The New York Rapid-Transit Subway," to be re-opened by Mr. Oliver Bury.

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Mr. C. Lewis Edwards, F.S.A.A., "Railways and the Trade of Great Britain."

Zoological, 3, Hanover-square, W., $8\frac{1}{2}$ p.m.

Wednesday, March 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Wynford Dewhurst, "Impressionist Painting: its Genesis and Development."

Meteorological, 25, Great George-street, W., $7\frac{1}{2}$ p.m.

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. Presidential Address by Lord Avebury, "Seeds with Special Reference to British Plants."

United Service Institution, Whitehall, S.W., 3 p.m. Colonel F. D. V. Wing, "The Distribution and Supply of Ammunition on the Battle Field."

British Archæological Association, 32, Sackville-street, W., 8 p.m.

Thursday, March 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lecture.) H. S. Hele-Shaw, LL.D., F.R.S., "The Navigation of the Air." (Lecture I.)

Royal, Burlington-house, W., $4\frac{1}{2}$ p.m.

Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. The Rev. Canon Norman, "The Podosomata of the Atlantic and the Arctic Oceans." 2. Mr. T. F. Chipp, "A Revision of the Genus Codonopsis." 3. Mr. E. Hindle, "The Holothurians from the Red Sea."

Chemical, Burlington-house, W., $8\frac{1}{2}$ p.m. 1. Mr. A. E. Dixon and J. Taylor, "The Constitution of Electronegative 'Thiocyanates.'" 2. Mr. W. R. Bousfield, "An Improved Form of Pyknometer." 3. Mr. F. D. Chattaway, "The Quantitative Conversion of Aromatic Hydrazines into Diazonium Salts." 4. Mr. H. R. Le Sueur, "The Action of Heat on *a*-Hydroxycarboxylic Acids. Part IV. Recemic *aa*-Dihydroxyadipic Acid and Meso *aa*-Dihydroxyadipic Acid." Messrs. H. Hartley, B. M. Jones, and G. A. Hutchinson, "The Spontaneous Crystallisation of Sodium Sulphate Solutions." 6. Mr. J. F. Spencer and Miss M. Le Pla, "Quantitative Relations of Salts of Thallium and its Separation from Silver." 7. Messrs. C. Smith and A. D. Mitchell, "Constitution of Hydroxyazo Compounds. Action of Diazomethane and of Mercuric Acetate."

Royal Institution, Albemarle-street, W., 5 p.m. Dr. R. T. Glazebrook, "Standardisation in Variou Aspects." (1.) Mechanical Engineering.

Optical, Finsbury Technical College, Leonard-street, E.C., 8 p.m. Demonstration by Professor Silvanus Thompson.

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Dr. W. E. Sumpner and Mr J. W. Record, "New Alternate Current Instruments."

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m. Sir Henry Howarth, "The Rise of Julius Cæsar, with an Account of his Early Friends, Enemies, and Rivals." (Part II.)

Numismatic, 22, Albemarle-street, W., $6\frac{1}{2}$ p.m.

Friday, March 20...Royal Institution, Albemarle-street, W., 9 p.m. Prof. J. Milnes, "Recent Earthquakes."

Civil Engineers, 25, Great George-street. S.W., 8 p.m. (Students' Meeting.) Mr. J. D. W. Ball, "Stresses in Brick Arches."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, $7\frac{1}{2}$ p.m. Paper by Prof. R. L. Weighton.

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Mr. W. Burton, "Persian Pottery."

Architectural Association, 18, Tufton-street, S.W., $7\frac{1}{2}$ p.m. Mr. H. Tanner, jun., "Some Notes on Domestic Work of the Rennaissance for England."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, March 21...Royal Institution, Albemarle-street, W., 3 p.m. Professor J. J. Thomson, "Electric Discharges through Gases." (Lecture III.)

Correction.—On page 408, column 1, line 8, in Mr. R. Cooper's remarks on Mr. L. M. Douglas's paper on "Modern Dairy Practice," *for* 15°, *read* 50°.

Journal of the Royal Society of Arts

No. 2,887. VOL. LVI.

FRIDAY, MARCH 20, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 23, 8 p.m. (Cantor Lecture.) PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." (Lecture III.)

TUESDAY, MARCH 24, 4.30 p.m. (Colonial Section.) The HON. C. H. RASON, Agent-General for Western Australia, "The Mineral Resources of Western Australia."

WEDNESDAY, MARCH 25, 8 p m. (Ordinary Meeting.) A. S. JENNINGS, "Recent Improvements in Decorators' Materials."

THURSDAY, MARCH 26, 8 p.m. (Howard Lecture.) PROF. H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." (Lecture II.)

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES.

On Monday evening, 16th inst., PROFESSOR VIVIAN B. LEWES delivered the second lecture of his course on "Fuel and its Future."

The lectures will be published in the *Journal* during the summer recess.

SHAW LECTURE.

On Tuesday evening, 17th inst., MISS NETTIE ADLER, Hon. Sec. to the Committee on Wage Earning Children, delivered the fifth Shaw Lecture on Industrial Hygiene, on "Child Workers and Wage Earners."

The lecture will be published in a future number of the *Journal*.

HOWARD LECTURES.

On Thursday evening, 19th inst., H. S. HELE-SHAW, LL.D., F.R.S., delivered the first lecture of his course on "The Navigation of the Air."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, March 12; The RIGHT HON. LORD CURZON OF KEDLESTON, G.C.S.I., G.C.I.E., in the chair.

The CHAIRMAN, in introducing the reader of the paper, said he was at the present moment a Member of the Council of the Secretary of State for India, and it would be known to all who had even the slightest acquaintance with India, that there was no man better qualified to address the Society on the subject of the Native States of India than the distinguished author. From the time that he entered the service of the Government of India, the whole of his service had been spent in connection with Native States, and there was scarcely one of the more important States of India, including Rajputana and Central India, and Kashmir, in which he did not leave his mark for good on the administration of the State, in the esteem of the rulers, and in the affection of the people. He (Lord Curzon) always regarded it as a singular piece of good fortune that it fell to his lot while he was in India to have the honour of conferring upon Sir David Barr what was regarded in India as the blue ribbon of the Indian political service, namely, the Residency at Hyderabad. He had the good fortune to send him there at a most difficult time, to fill a most difficult place, and to conduct a most difficult negotiation. All those operations he conducted with the success which had attended every stage of his career, and it was the fitting crown

to a long and brilliant service that, on coming home to this country, he was, because of his particular qualifications and attainments, selected by the Secretary of State for his council in London.

The paper read was—

PROGRESS IN THE NATIVE STATES OF INDIA DURING THE PAST FORTY YEARS.

By Sir David W. K. Barr, K.C.S.I.

I hope the subject I have chosen for consideration this afternoon will not unduly alarm my audience. I recognise the fact that a full and detailed disquisition on the progress made year by year, during forty years, in all the Native States of India, would be as laborious for me to undertake as it would be tedious for you to listen to, and I may as well unburden my own mind, and relieve yours, by saying that all I propose to do is to lay before you certain facts relating to some of the more important States; to endeavour to describe the condition of those States as it existed forty years ago; and then to show the moral and material progress attained in them during the period under review. I hope to illustrate my remarks by showing you, at the close of my address, some lantern slides of types of old and new buildings, and places of interest in Rajputana and Central India—in Hyderabad and Mysore.

I have taken the period of the last forty years for three reasons: first, because it is during that time that progress has been most marked; secondly, because this is the fortieth Session of the Indian Section of this Society, and the season seems appropriate to a review such as I am attempting; and thirdly—and I mention this incidentally, as an apology for my appearance before you on this platform—because my own connection with the Native States of India coincides with the period to which I allude.

I am tempted to give you some of the impressions that remain with me after nearly forty years of work in the Native States of India. They are to me delightful memories, and I shall be glad if I can convey to you some of the thoughts which those years recall. There are many among the audience who have shared my experiences, and they will bear me out when I say that some of the most fascinating parts of India are to be found in the Native States. The climate is not always very good, as those can testify who have passed hot weathers and rains in certain parts of Gwalior, Jodhpur, Jaipur and Bikanir; and the amenities of life, as known in presidency towns and in most of the civil and military stations in British India, are restricted. But there is a peculiar charm in the land of the Rajas, and in the old-world courtesy which one meets, perhaps more especially in Rajputana, but to a great extent in all Native States—there is a freedom of thought and action, a sense of responsibility, a pleasure in being associated with the life, manners and customs of the rulers, and the subjects of these principalities which are at once engrossing and refreshing. Englishmen feel themselves at home with a race of independent, high-spirited people, whose ancient lineage and romantic, chivalrous past compel respect and admiration, and these feelings are accentuated by the friendly welcome, the genial kindness and hospitality, and the frank confidence extended to those who show their appreciation of these qualities. I have spent many months of many years travelling in camp through Malwa, Rajputana, and Baghelkhund, but I do not remember passing a single dull day, for I lived with the men of the country, and they told me all they knew of its history and traditions—the old forts and strongholds, in their hills and forests, illustrated their tales, and were, verily, "sermons in stones." I have seen the cities, the ancient palaces, the temples and mosques of nearly every State in Central India and Rajputana. I have taken part in every kind of State festival and pageant, and I have had my share of the excellent sport still to be obtained in their beautiful forests and jungles. I have watched, with the greatest interest and sympathy, the progress made, during my service, in the Native States, to which I was accredited. I know what the difficulties have been, and how hard it is to break down old prejudices and customs, and to engraft in the minds of a very conservative people the advantages of Western culture and the first principles of modern rule and administration. I am proud of the friendships I have made with many of the chiefs of India—Rajput, Mahratta, and Mohammedan. But the people of the soil, the patient, simple, hard-working peasants, they, in their millions, command, equally with their chiefs, our sympathy and respect. And when I remember how I have seen them in their prosperity, strong, healthy, cheerful folk, reaping rich crops, and herding fat cattle; and then, at other times,

in their distress, stricken with famine, mere skeletons literally gasping for life, but still patient and uncomplaining, I cannot but feel, as all must feel who have lived and worked in their midst, that anything we have done for their good, no matter how hard the task, nor how long it took to accomplish, brings its own reward.

I will ask you to look at this map of India: It shows in yellow, in contradistinction to the red of British India, the areas occupied by Native States, and the manner in which they are distributed and grouped, from Kashmir in the North to Travancore in the South, from Kathiawar in the West to Manipur in the East.

When some people in England talk of the Indian Empire, they are apt to forget that Native States, in the aggregate, cover 680,000 square miles, or more than one-third of the whole of India, and about five times as large an area as that of the United Kingdom and Ireland, and contain a population of 66 millions out of a total of the 300 millions of India, or about 22 millions more than the population of these Isles; and that, although the States form an integral part of the Empire, and are dependent for their existence upon the protection of our Government—on conditions of loyalty to the Crown of England and the faithful fulfilment of the treaties and engagements on which they are held; still, within that area of 680,000 square miles, and over that population of 66 millions, the administration is conducted by Indian chiefs under their own laws and regulations.

There are, in all, more than 600 Native States, and full sovereign rights are exercised only by those that have entered into alliance by treaty with the Government of India; the smaller States, and these, of course, form the majority, have not powers of life and death, and refer cases of heinous crime for trial in the courts of Political Officers.

But in the administration of their internal affairs the Government of India does not interfere in States great or small, save in cases of gross misgovernment, or during a period of the minority of a ruling chief. Nor does the Government exercise anything more than a political jurisdiction which extends to a general supervision and guidance. And here I would offer for your consideration the suggestion that the success, or failure, of our dealings with Native States depends entirely upon a correct appreciation of the extent to which we should supervise, and the manner in which we should guide, the actions of the Rulers. In the multiplicity of States, and the diversity of their size and importance, as well as their financial condition, their geographical position, their past history and present status, their obligations to our Government, and in no less degree, the obligations of our Government to them, there is an immense scope for the exercise of wisdom, tact, and prudence. We have to avoid the Scylla of *laisser faire* and the Charybdis of undue interference, and to steer the middle course, which an ancient maxim lays down as the safest in all the affairs of this life.

History shows that in our earlier relations with the great States of India there was a want of fixity of purpose and of continuity of policy. Lord Cornwallis in 1805 instituted a policy of non-interference, with the result that the Mahrattas invaded Rajasthan, levied *chouth*, or a tax of one-fourth of their revenues on the ancient States of Rajputana, and further proceeded to despoil and plunder the country. As the Mahratta power decayed, the Pindaris, trained bands of freebooters, whose hordes were over-running Malwa and Rajputana, carried on the work of depredation, until the British Government, thoroughly roused to a sense of the danger which lawlessness in Central India and Rajputana threatened to their prestige, took affairs into their own hands, broke the last efforts of the Mahrattas by overthrowing the army of Holkar at Mahidpur in 1818, and thereafter entered into alliance with the Rajput princes, and waged sharp and decisive war against the Pindaris.

The map illustrates the settlement of 1818. Here we have all the great States of Rajputana, Udaipur, Jaipur, Jodhpur, Bikanir, Kota, Bundi, Kishangarh, and others, grouped together. Adjoining them, to the south and east lie the States of Central India—Gwalior and Indore—representing the Mahratta leaders, Scindia and Holkar; Bhopal—originally an appanage of the Mogul Emperor Aurungzeb, held by an Afghan soldier of fortune named Dost Mahomed as an independent State, and maintaining its independence by the treaty made in 1818 with the British Government; the Powar States of Dhar and Dewas, and the numerous Rajput chiefships which fall under the head of mediatised States. These are mingled in inextricable confusion with the larger States, and exemplify in the most striking manner the result of the sudden British intervention in 1817 after years of invasion, conquest, and depredation by the

Mahrattas and Pindaris. It is as though a pack of hungry wolves, tearing a carcase to pieces, had been suddenly turned into stone, each holding the piece of meat, or the bone, in his possession at the moment of transformation. To emphasise this simile, I draw attention to the now flourishing Mohammedan States of Tonk in Rajputana and Jaora in Central India, which were assigned in 1818 to the famous Pindari leaders, Amir Khan and Ghafur Khan, on condition of abandoning their predatory system, dispersing their armies of freebooters, and furnishing a body of troops to co-operate with the British force.

Then followed a period of activity and direct administration. Sir John Malcolm's settlement of Central India was a gigantic task, as it involved the adjustment of the rights of some 80 or 90 small chiefships. To each of these were granted *sanads*, or guarantees of protection, signed by Malcolm or his assistants, on which, to this day, they hold the lands wrested by force of British arms from Mahrattas and Pindaris. These measures are thus described in Aitchison's "Treaties" :—

"The policy pursued by the British Government was to declare the permanency of the rights existing at the time of the British occupancy on conditions of the maintenance of order; to adjust and guarantee the relations of such chiefs as owed mere subordination or tribute, so as to deprive the stronger powers of all pretext for interference in their affairs, and to induce the plundering leaders to betake themselves to peaceful pursuits, either by requiring their superiors to grant them lands under the British guarantee, or by guaranteeing to them payments equivalent to the *tankhas* which they levied."*

This settlement was not fully completed until the years 1829-30.

Then followed a long period of inaction: breathing time was doubtless necessary to enable the larger States to recover from the effects of many years of unrest and plunder, and for the small chiefships to settle down in their new position, but by degrees this freedom from trouble engendered lethargy on the part of the chiefs, while the Government seemed content with having secured, under the terms of protection and subordinate co-operation which the treaties enunciated, the practical isolation of the large States, and were fully occupied in extending the Empire of India.

The disastrous war in Afghanistan, 1839-41, was followed by the conquest of Sind in 1843, the first Sikh War in 1845, the second Sikh War and annexation of the Punjab in 1849, and of Burma in 1852.

* Aitchison's "Treaties." Vol. IV., Central India.

When Lord Dalhousie turned his attention to the feudatory States the conclusion he arrived at was that their administration was so bad that, in pursuance of his maxim of "the good of the governed," he determined to follow, whenever opportunity offered, a policy of annexation by applying the doctrine of lapse on failure of direct heirs. The first State to escheat was Satara in 1849; then followed Jhansi and Nagpur in 1853; and the kingdom of Oudh in 1856.

The Mutiny of 1857 evoked the loyalty of the Native States and established their value to the Empire. With hardly an exception the chiefs of India stood fast for British rule. The Nizam of Hyderabad and his distinguished Minister, Sir Salar Jung, probably saved the whole of Southern India, while all the chiefs of Rajputana and Central India were true to their allegiance; and many of them received rewards of land, money, and titles, for their services during the Mutiny.

Finally, on the assumption of the Empire of India by the Crown, the policy of annexation was for ever abandoned, by the grant, in 1861, to all the feudatory princes of the right of adoption. As Lord Canning wrote :—

"The Crown of England now stands forth the unquestioned ruler and paramount power in all India, and is for the first time brought face to face with its feudatories. There is a reality in the Suzerainty of the Sovereign of England which has never existed before, and which is not only felt but eagerly acknowledged by the chiefs."

I have dealt at some length with the history of the two groups of States of which I am now speaking, *viz.*, Rajputana and Central India, in order to show that, during the first fifty years of our political relations with them they had been subjected to frequent changes of policy, that these changes had an unsettling effect on them, amounting, during the later period at least, to alarm lest they too might fall victims to the policy of annexation. I may be overstating the case on their behalf, but at any rate it may be admitted that their doubts as to the intentions of the British Government offer some excuse for the fact that from 1818, when they first came under alliance with the East India Company, until the transfer to the Crown of England in 1858, their condition remained unchanged, and that in spite of the rapid progress attained in the pacification and administration of British India, they showed no symptoms of advancing with the times.

During the ten years 1858—1868 there was a certain amount of progress and improvement, but it was relatively slight and it was a common observation in those days that Native States were a hundred years behind the rest of India.

We have only to read the published reports of 1868 to appreciate the position. In the first place, there was not a mile of railway in any State; the only communications that existed were the Trunk Roads made and maintained by the Government of India, and such traffic as there was found its way over the deserts of Marwar, and by cross-country tracks through Rajputana to these high roads. Transit dues, levied in every State, further hampered trade; law and order did not exist. Every chief lived in a state of suspicion of his neighbour, while their feudatories were in a condition of rebellion, and instead of assisting in the preservation of the States, were doing all in their power to bring about their destruction.

There are several reasons to be ascribed for this condition of affairs; but I think it may be said that first and foremost among these was the isolation to which I have alluded. The proud families of Rajputana cherished then (as indeed they do to this day) the traditions of their ancient lineage, and the glories of the days when their ancestors divided between them the dominion of Hindustan in the kingdoms of Delhi, Kanouj, Mewar, and Anhulwarra, which they had held undisturbed for nearly 800 years, before the invasion of Shahab-ud-din, the Afghan King of Ghor, in 1193 A.D. Though shorn of their former greatness, they still retained their identity as ruling chiefs; and their pride of race made them cling with tenacity to ancient forms of government and the feudal systems of their clans. They viewed with disdain any change from the manners and customs of their ancestors, handed down to them, through the ages, in legends recited by their bards; and when peace was restored to them they lapsed into the pomp and magnificence of Rajput princes, and, wrapped in their own importance, took no thought of their subjects, and refused to learn the art of governing in accordance with the ideas of modern times. Sir Henry Daly, writing in 1868, says:—

"Colonel Sutherland, Resident at Gwalior in 1837, described Esagurh, Bhilsa, and Malwa, as desolate and miserable. Thirty years have brought no change for the better. Travellers still go armed to the teeth, and in many places the man at the plough has a sword by his side. Traders going from village to village are not safe without an armed escort. To men accustomed to districts under British rule, such a statement must seem fabulous. It is necessary to live and move in Native States to know the nature of the system under which they exist."

In 1868, Central India and Rajputana were visited by a disastrous famine, which grew intense in 1869, and did not disappear until 1870. Here is a sketch which shows how hopeless was the condition of the people, and how helpless were the chiefs in affording relief:—

"Within the States of Central India, the past year (1868) has been marked by all the terrors of famine and disease. Thousands perished from sheer starvation, and thousands from cholera. Villages, and even districts, were depopulated, and there were none left to tell how many of the inhabitants had sunk under the miseries which oppressed them. Scindia computes the casualties, in the neighbourhood of Gwalior, at 92,987. With the exception of a few places on the western border, Malwa suffered not at all from drought, but the streaming crowds from Rajputana and Gwalior brought in their train disease and death. Of the mortality among these wanderers it is impossible to form an opinion. Marwaris, lank and emaciated, came pouring down through every outlet into Malwa; there are no data of their numbers. Bodies and bones were found in *nalas* (ravines), and on the plains, under trees, and upon the wayside; and this over a vast space. Even so late as 1870 an English gentleman, marching through Rajputana to Indore, encountered human beings, living and dead, in every form of misery, and witnessed scenes too horrible to be described."

In 1870 Native States were still quivering under the strain, for where famine was heaviest there were no means of alleviating it, neither roads nor approaches.

This is the sad tale of famine in Central India in 1868; the record for the same year in Rajputana is even worse. The rains failed so completely that the autumn crop (the chief harvest in those parts) was almost entirely lost, and there was an utter dearth of grass for pasture or fodder, and, in some parts, of water, so that it was impossible for the cultivators to feed their cattle, or for traders to import grain on bullocks or carts, or by any other means than camels. Within an area of 100,000 square miles the suffering was severe. The greatest intensity was in Marwar, Bikanir, and Ajmir. The only resource open to the people was emigration, and they emigrated in enormous numbers. It was estimated that from Marwar alone one million people, or two-thirds of the population, emigrated; and that in all, throughout Rajputana, one million and a

quarter of human beings died from starvation or disease.

Colonel Brooke, Political Agent in Marwar, wrote :—

"For the alleviation of distress in Marwar no public works were undertaken by the Maharaja, nor was any assistance given either to the poor of the city or to ryots in the villages. The *hákims* and revenue officers squeezed the last penny from them, and when the great emigration took place, the customs' agent at the Dasuri Pass, before letting them through, not only forced from them the cesses due for the year, but also a cattle tax for each head of kine taken out of the country, though the departure was forced by the drought. It is but justice to say that this mode of getting money was reprobated throughout Marwar."

Now it must be remembered that by 1868 Lord Dalhousie's great scheme for the construction of railways in British India was well advanced. There were, at that time, 4,000 miles of open lines. Bombay was in direct communication with Calcutta and with Madras. The East India Railway was open from Calcutta, through Allahabad, to Agra. The line from Bombay to Baroda and on to Ahmedabad was completed. Railways almost encircled Rajputana and Central India, but, except at one point, nowhere touched them within a hundred miles ; and these groups of Native States, covering 200,000 square miles, and containing 18 million souls, were lying unprotected by communication with the rest of India—a prey to the devastation of famine. But it was not only railways and roads that were wanting ; there were no public works of any kind. Education was neglected ; there were in Central India only 35 schools, teaching 1,200 pupils, and Jaipur was the only State in Rajputana in which anything like an educational department existed. With but few exceptions the administration was bad in all the States. The land revenue was farmed to contractors, and collected by force. There was no attempt to administer justice. The police were useless ; and in many States there were large gangs of Dakaits and criminal tribes, such as Minas, Moghias, and Baories, who plundered villages, and attacked traders and travellers. Discontented Thakurs went into outlawry, and led these marauding bands.

I do not wish to enlarge upon the sorry condition of Rajputana and Central India in 1868, but I will quote a few remarks from official reports of that year which will be sufficient to show that States now in the forefront of progress were, at that time, suffering from the effects of misrule.

Jodhpur.—Unfortunately the history of the administration is unrelieved by a single bright feature.

Bikanir. — The condition of Bikanir is almost as bad as it is possible to be.

Alwar.—The Political Agent has commenced his difficult task of rescuing the State from the gross misrule of the chief, which has resulted in scarcity, and open warfare.

Kota.—The condition of the Kota State is the cause of much anxiety.

Rewa.—The Maharaja possesses a splendid palace, standing in a miserable collection of hovels ; a type of the condition of the State.

Bundi is described by the Political Agent as being in a fossil condition, a living representation of Native States in the last century—apathetically indifferent to progress, and obstinately opposed to change.

It is pleasant to note, as a contrast to these criticisms that, in 1868, Jaipur had already attained a high reputation among the States of Rajputana for civilisation and progress. The State was well and wisely governed by the Maharaja Ram Singh, an enlightened chief whose name is still revered, and who was the first to encourage the education, not only of his subjects, but of the sons of the aristocracy ; to promote public works and irrigation, and to foster local arts and industries. He was the first chief to establish a Council to assist him in the administration. On this innovation the following remark is recorded :—

"It must take, necessarily, a longer time and a greater amount of application than the Maharaja has yet had an opportunity of bestowing on the question, to rid himself effectually of the deep-seated and obstructive practices which are, so to speak, inherent in the very constitution of Native States."

In Central India the Maharajas Scindia and Holkar were conducting what may be called a strong Government. They had no refractory feudatories to control, and their States were comparatively prosperous, while both chiefs had amassed great wealth. Still, in neither case was their rule framed on any basis of benevolence to their subjects. The collection of revenue was held in higher estimation than the preservation of law and order, and no serious efforts had yet been made for the good of the people, nor for any kind of moral or material progress.

In Bhopal, the long succession of Begum rulers, commencing with the Regency of the Kudsia Begum in 1818, and still continued by her great grand-daughter, Her Highness the Sultan Jehan Begum, G.C.I.E., had secured a

firm but, at the same time, considerate form of Government; and during the Mutiny of 1857 the Sikandar Begum showed remarkable powers of control over her State, and proved her loyalty to the British Government. Nevertheless, Bhopal shared with other principalities of Central India the absence of communications by road or rail, the want of protection from robbers, and the difficulties of an administration conducted by corrupt and inefficient officials.

The Other Side of the Picture.

I now turn to a consideration of the progress made, since 1868, in the group of States in Central India and Rajputana, and I will take first the extension of railways, this being the most important of the changes effected, and the one on which the prosperity of the States so largely depends.

As I have already mentioned, there were no railways in these States in 1868. There are at the present time 2,656 miles of line opened and in full working order. I trace them on the map, and you will see that there is hardly a State in the two Provinces which is not now traversed by the iron road; while communication with British India and with the ports of Karachi, Bombay, Calcutta, and Madras, is open from north, south, east, and west.

The first impulse to railway extension was due to the initiative of Sir Henry Daly, Agent to the Governor-General in Central India. In 1870 he persuaded the Maharajas Holkar and Scindia to offer loans aggregating 2½ millions sterling for the construction of the lines from Khandwa, on the Great Indian Peninsula Railway, to Indore, and on to Nimach, and from Agra to Gwalior. These beginnings were the bases of the two great systems now known as the Rajputana-Malwa and the Midland Railways. The first portions of these lines were opened for traffic in 1873, and by 1880 the mileage in Central India and Rajputana was 1,182, the capital cost of which was close on 800 lakhs, or nearly 5½ millions sterling.

The Begum of Bhopal advanced 50 lakhs (£333,000) for her portion of the Midland Railway between Itarsi and Bhopal—opened in 1885. The present Maharaja, Madho Rao Scindia, has constructed 145 miles of the Bina-Guna-Baran Railway. He shared with the Begum of Bhopal the construction of 113 miles from Bhopal to Ujjain, and he also owns a portion of the Godhra, Rutlam, and Nagda Railway. In addition to these lines His Highness has constructed 183 miles of light railway in his own territory. The total mileage of open lines in Central India in 1907 was 1,080.

Of the railways in Rajputana, the Maharajas of Jodhpur and Bikanir have jointly constructed 824 miles of line—Jodhpur 455, and Bikanir 369. Capital outlay 173 lakhs, paying a return of 8 per cent. The Maharaja of Udaipur has spent 21 lakhs on 67 miles connecting Udaipur with Chitorgarh. The Maharaja of Jaipur is constructing 73 miles of railway in his State, of which 40 miles are now open; while the Kotah State has expended 17 lakhs on that portion of the Bina-Baran line, running through Kotah territory. Altogether, in Rajputana, there are 1,576 miles of railway, of which 739 are British, and 837 belong to the various Durbars I have named.

An important line from Nagda to Muttra is now under construction. The distance is about 350 miles, and it will greatly benefit the Gwalior, Kotah, and Jaipur States, and open up some rich tracts of country.

It is needless to emphasise the advantages which the railways have secured; protection against famine, expansion of trade, facilities to travellers. Perhaps the most noticeable result is the civilising effect they have produced upon the formerly isolated States, by bringing them into direct communication with the rest of India, and, indeed, with the world. I remember in 1870, Sir Henry Daly, in a report to the Government of India, wrote:—"The railway will bring light in its train." One of his assistants ventured to draw his attention to the sentence, and suggested that it savoured of a joke. Sir Henry replied, "No joke, sir; let it stand;" and I think the verdict of 38 years establishes the truth of his prediction, for the railway has indeed brought light into many dark places, and has practically changed, not only the face of the country, but the character of the people, and the attitude of the ruling chiefs.

Irrigation and other Public Works.

Under this head very considerable progress has been made since 1868. In Jaipur, which has benefited throughout the period by the eminent services and remarkable talents of Colonel Sir Swinton Jacob, 66 lakhs (nearly £440,000) have been expended on irrigation alone, and it is satisfactory to note that the revenue from these works has already reached 60 lakhs (£400,000), while the benefit to the State is evident from the fact that 436 square

miles (or 33 per cent. of the cropped area) are under irrigation. In Udaipur, Jodhpur, and Bikanir, attention has been paid to irrigation only of recent years, and the full benefit of the money spent in these works has not yet accrued. In Bikanir, in spite of the sandy nature of the soil, two canals—one 29 miles, the other 32 in length—have been constructed from the Ghugger Canal system in the Punjab, at a cost of 4½ lakhs (£30,000). In Udaipur, where the prospects of irrigation are more favourable, an English engineer has been engaged for irrigation, and some 5 lakhs (£33,330) have been expended. Throughout Rajputana one-sixth of the cropped area is irrigated.

In Central India, irrigation is carried on chiefly from wells, and, with the exception of Gwalior, which has the benefit of the services of an experienced irrigation engineer, and where some important schemes have been commenced, none of the States do more than increase the number of wells. But this form of irrigation has been so successfully prosecuted that the total area under irrigation in Central India is estimated at about 1,140 square miles, or 6 per cent. of the total cultivated area.

Roads.—More than 1,000 miles of metalled roads have been constructed by States of Rajputana since 1868, and 640 miles in the same period in Central India. The total length of metalled roads now maintained by States in Rajputana and Central India is about 3,000 miles.

Famine Administration.

Famine administration is, perhaps, the greatest test that can be applied to the administrative capacity of a Native State. You will remember the details I gave of the famine of 1868-70, when both in Rajputana and Central India the Durbars utterly failed to grasp the situation, or to afford relief to the starving population. Rajputana is, unfortunately, subject to drought. A Marwari proverb says, "Expect one lean year in three, one famine in eight." In 1877-8 there was a famine in Rajputana, and although it was not so severe as that of 1868, still its ravages were awful—200,000 people emigrated, and the few attempts made towards affording relief were unorganised and inadequate. The Alwar State lost one-tenth of its population, and Jodhpur and Bikanir suffered severely. In 1891-2, in face of another famine, for the first time, organised relief was given. Railways now supplied grain in ample quantities and prices did not rise 20 per cent. above normal.

In 1899-1900 there was a severe famine. There was large emigration, chiefly with a view to taking cattle out of the parched districts for pasture and fodder in more favoured places. But the States of Rajputana rose to the occasion and relief was given on an unprecedented scale; in all 146 millions of units were provided for at a cost of 104 lakhs (£693,264) from States, and 24 lakhs (£160,000) from charitable relief funds, besides loans of 24 lakhs to *ryots* (cultivators), remission of revenue amounting to 28 lakhs, and suspension of 48 lakhs. The States borrowed 63½ lakhs (£523,291) from the Government of India, who also lent Engineers and famine officers.

In Central India famines occurred in 1896-7 and again in 1899-1900. In the first of these years the areas affected included large parts of Gwalior, and the whole of the Bundelkhand and Baghelkhand agencies, an area, roughly, of 30,000 square miles and a population of 4,000,000. In 1899-1900 the western part of Central India, including Malwa, was affected, the area being 38,000 square miles, and the population 4,500,000. Speaking generally, on both these occasions the Durbars made gallant efforts to meet the trials. The promptitude displayed, especially by some of the smaller States, was most praiseworthy. Some idea of the cost to which these States were put, after exhausting their own resources, may be gathered from the fact that between October, 1899, and March, 1902, they borrowed for famine expenditure no less than £214,500. Of this sum H.H. Maharaja Scindia, besides providing for his own State, lent to his brother chiefs £80,000.

In 1896-7 the total numbers on relief works in Central India were 2,900,000, or a daily average of 320,000 persons — equivalent to 7 per cent. of the population of the affected area—while 89,000 received gratuitous relief, the cost to the States amounting to 85 lakhs (£566,610). In 1899-1900 altogether 33,000,000 units were relieved on regular works or by charity—the cost to the States being 148 lakhs (£986,568). In the two years, 1896-7, and 1899-1900, the Central India States spent £1,553,178 on famine relief.

I do not for a moment claim that the famine administration of these Native States was to be compared with the organised relief in British India. I know full well, and from personal experience of both famines in Central India, that no such comparison can be made.

I know that some chiefs failed in their duty, that in some States relief was not properly organised—or that it was organised too late to be effective—that thousands of persons died from starvation, and many thousands fled from the States before they knew of the relief that was available, or because they did not believe that any relief would be afforded, and joined famine works in British districts, where they were assured of succour. But the fact I want to elucidate is that, in comparison with the record of all previous famines, the relief given by the Durbars, in 1896-7 and 1899-1900, was a remarkable and praiseworthy effort. Some of the chiefs were more active and generous than others; the Maharaja of Jaipur, for instance, besides providing for the wants of his own people, gave a princely subscription of 21 lakhs (£140,000) to the Famine Trust Fund of British India. Maharaja Scindia personally visited his famine relief works, poor-houses, and kitchens. So did the Maharajas of Rewa, Kishengarh, Bikanir, and others. In both famines, and in all parts of Rajputana and Central India, private charity was largely extended by chiefs and people; by British officers, both military and civil; and by missionaries of various denominations, whose labours in administering relief to starving wanderers, are deserving of the highest praise. Liberality and munificence were shown even in the zenanas of princely houses, and we must not forget the noble example set by the wife of that gallant soldier, Maharaja Sir Pertab Singh—then the first noble of Jaipur, and now the ruling chief of Idar—who not only established an orphanage, but remained there herself to administer her great charity.

General Administration.

A complete change has come over the administration of all the States of Rajputana and Central India. In nearly every large State the old plan of farming land revenue has given place to the organised system of survey and settlement. Even in the more conservative principalities of Udaipur, Jodhpur, and Jaipur, these reforms have been carried out to the great advantage of the people, and to the gradual expansion of the revenues of the chiefs; and the example has been followed in most of the other States. The administration of justice has also greatly improved. Nearly every State has abandoned the old system, which was described as showing a determination to make a profit out of crime rather than an honest desire to inflict a really deterrent punishment, and has adopted laws based on the Codes of British India.

Transit dues, which used to form a large item in the receipts, have been everywhere abolished, to the great benefit of trade.

The Police has been reorganised, and successful efforts have been made to suppress dakaiti and violent crime. Jails have been modernised, and are no longer subject to the reproach of being "filthy places without light or air, where convicts and prisoners under trial were indiscriminately chained together."

Education.—In Central India there are now 1,057 schools, teaching 57,064 boys and 1,693 girls. Of these institutions 4 are arts colleges, 60 are secondary, and 781 primary schools. In Rajputana there are 647 schools, of which 510 are kept up by the Durbars, 103 are private, and 34 maintained by missions. There are 4 arts colleges, 86 secondary, and 545 primary schools; pupils number 37,670. All education is free and the annual cost to the States is 3½ lakhs (£23,300). I draw attention to these figures, not because they represent anything like an adequate amount of education, for, in point of fact, they indicate that on an average only 4 per cent. of the youth of the States of the school-going age attend schools, but rather to show that some progress has been made since 1868.

Medical Institutions have been established in every State. In 1872 the hospitals and dispensaries in Rajputana numbered 63, where 157,250 patients were treated at a cost of Rs. 41,707 (£2,700). The latest reports give 178 hospitals and dispensaries, where 1,015,508 patients were treated in the year at a cost of Rs. 3,05,475 (£20,002). In Central India the figures for the same periods were: 1872-64 hospitals and dispensaries, 109,390 patients, expenditure, Rs. 44,250 (£2,900); present time, 147 hospitals and dispensaries, 1,357,000 patients, and expenditure Rs. 4,33,000 (about £28,800).

The financial condition of the States has been put on a sound basis, and a system of Budgets of Income and Expenditure introduced. Prior to 1868 nothing was known of their finances beyond the fact that, while some chiefs had enormous wealth, many others were deeply involved in debt. In spite of the expenses incurred in the relief of famine, the construction of railways, irrigation works, roads, and buildings, and the maintenance of an improved administration, the resources of States have largely increased, and the total

revenues of Rajputana and Central India have expanded by more than 60 per cent. during the past 40 years. Some of the figures are remarkable. For instance :—

Gwalior has increased from Rs. 1,10,1900 (£734,600) to Rs. 1,63,8400 (£1,092,200).

Indore from Rs. 50,00,000 (£333,000) to Rs. 76,00,000 (£506,600).

Bhopal from Rs. 26,00,000 (£173,300) to Rs. 40,00,000 (£266,000).

Udaipur from Rs. 26,87,000 (£179,200) to Rs. 36,60,000 (£244,000).

Jaipur from Rs. 42,32,000 (£282,133) to Rs. 68,18,000 (£454,000).

Jodhpur from Rs. 25,00,000 (£166,000) to Rs. 63,00,000 (£420,000).

Bikanir from Rs. 11,00,000 (£73,000) to Rs. 28,00,000 (£186,000).

Kota from Rs. 24,00,000 (£160,000) to Rs. 38,00,000 (£275,000).

Alwar from Rs. 21,31,000 (£142,000) to Rs. 28,00,000 (£186,000).

Rewa from Rs. 10,00,000 (£66,000) to Rs. 21,00,000 (£140,000).

In my description of affairs in 1868 I quoted brief extracts from reports on Jodhpur, Bikanir, Alwar, Kota, and Rewa. It is only fair to describe their condition in recent years.

Jodhpur.—Referring to the death, in 1895, of the Mahajara Jaswant Singh, the following is a summary of the progress made in the State during his rule :—

"At his death, his late Highness left the State prosperous and happy in every way, with a largely increased revenue and a well-regulated expenditure. Among the many benefits His Highness conferred upon his subjects are—the construction of lines of railway, which have already saved the State from a great famine, and have proved profitable undertakings; the damming of the Luni river by the Jasmunt Samand Bandh, which not only protects a large area by direct irrigation, but has also raised and sweetened the well-water in villages on both sides of the river below for about 100 miles; the improvement of public health by the spread of vaccination; the increase of dispensaries; and the provision of a better drinking-water supply at Jodhpur; the arrangement come to with the Jagirdars, whereby their sympathies have been enlisted in the cause of law and order, and they have become loyal supporters of the administration; the greatly improved efficiency of the Courts and the Police, and the steady and successful efforts to settle down the members of criminal tribes, which have resulted in the great diminution of crime against person and property; and the vast work comprised in the settlements of internal and external boundaries, which was followed by the introduction of a Survey and Land Revenue Settlement now approaching completion."

The present Maharaja, Sirdar Singh, succeeded his father, and during his minority the administration of Jodhpur has been ably conducted by a Council of Regency, under the general superintendence of the Resident. It is hoped that ruling powers will be given to the present Maharaja during the current year.

Bikanir, 1881.—The administration was still not what could be desired; the relations between the chief and his thakurs continued in a state of tension, and in 1883, disputes with them led to a rebellion of many of the nobles which necessitated the despatch of a small British force into the State, when the thakurs quietly submitted. An administrative change of great importance was effected by the abolition of the old Civil and Criminal Courts at the capital, and the establishment of regular Courts at four important centres of the State. The Customs Department underwent thorough and sweeping reforms. A reformed currency was introduced under the Native States Coinage Act. The Ghaggar Canal scheme was completed in conjunction with the Punjab Government, and Bikanir was linked up by the Jodhpur Railway system. The Maharaja, Major Sir Ganga Singh, was invested with governing powers in December, 1898, and the administration is now carried on by His Highness with the aid of a Council consisting of five members. The net earnings of the railway represent nearly 8 per cent. of the capital cost. A colliery at Palana is yielding profitable returns to the State.

Alwar.—When the Maharaja Sheodan Singh was deprived in 1870 of his powers on account of misgovernment, a Council of management, presided over by a British officer, was formed. Since that date the affairs of Alwar have progressed most satisfactorily. Sheodan Singh was succeeded by his son, Mangal Singh, a minor, in October, 1874. In 1877 the Maharaja was invested with governing powers. His Highness introduced a reformed coinage under the Native States Coinage Act. He attended punctually to business, and interested himself in everything connected with the affairs of his State. Mangal Singh died in May, 1892, and was succeeded by Jai Singh, a minor, the administration being conducted by the Council under the guidance of the Political Agent. The financial position is sound; the cash balance at the close of the year 1899-1900 was over 59 lakhs, of which some 52 lakhs were invested in Government Securities.

Kota.—The following is an extract from the

Political Agent's report:—"When the Kota State was brought under management in February, 1874, the Treasury contained only 1,519 rupees (£100) in cash, while the claims against the Durbar amounted to Rs. 89,58,140 (nearly £600,000)." Enquiry reduced the debts to Rs. 46,43,125 all of which have been paid, and the cash balance in the State Treasury on the 31st March, 1893, was Rs. 15,39,187 (£102,000). The total amount spent on public works has been Rs. 45,95,187. A nobles' school was opened in 1894 for the sons of Jagirdars. In 1897 the Maharao Umed Singh was invested with full powers of administration and has since conducted his rule with wisdom and prudence.

Rewa.—In 1871 the Government of India granted the State a loan of Rs. 10 lahks to extricate it from financial embarrassments. The revenue was estimated at about 26 lakhs, but no less than 16 lakhs were alienated in jagirs, religious, and charitable grants, &c. The debts amounted to over 26 lakhs. Matters gradually drifted from bad to worse until, at length, the Maharaja asked in 1875 that the management of his territory might be undertaken by the Political Agent with the assistance of the Minister. The proposal was accepted, but the Political Agent had no real power to enforce his orders. The police were worse than useless, the army was badly officered and disciplined and unwilling to act against the rebellious nobles. Maharaja Raghuraj Singh died in February, 1880, and was succeeded by the present chief, then a minor. The administration was vested in the Political Agent as superintendent, with a consultative council composed of the principal nobles and officers. The forests of the State were examined and reported upon by an expert. A village settlement for five-year leases was commenced. The State army was reorganised. Public works were placed under an executive engineer lent by Government. Experiments for determining the extent and value of the Rewa coalfields proved highly successful. The revenue continued to increase and reductions of expenditure were made. Most of the urgent public works were completed, relieving the Treasury of heavy outlay, and by 1891 the financial position was sound. The State was free from dakaiti and other violent crime. Meanwhile the young Maharaja was thoroughly educated and fitted for his future duties. Ruling powers were conferred upon him in 1895 when the Council of Regency was dissolved The administration is ably conducted by the Maharaja. The revenues have expanded from 10 lakhs in 1871 to 30 lakhs in 1907, and there is a handsome balance of about 8 lakhs in the State Treasury.

Hyderabad.

Hyderabad is by far the largest State in India. It covers an area of 82,628 square miles, and contains a population of about 11½ millions. His Highness the Nizam, Sir Mahbub Ali Khan, G.C.B., G.C.S.I., is the premier Chief of India. He succeeded his father in 1869 when he was but three years of age, and for fifteen years, during the minority, the State was ably administered by the great statesman Nawab Sir Salar Jung, with whom was associated the Nawab Shums-ul Umra. Some idea of the condition of Hyderabad in 1869 may be gathered from the following programme of measures of reform laid down by the Government of India for the observance of the joint administrators:—

"The settlement of all past accounts with the creditors of the State, the release of all districts mortgaged or assigned to chiefs of various denominations in satisfaction of debts, or for the payment of troops and establishments, the gradual reductions of those portions of the army which were not really needed for the defence of the country, the working of the police, the completion of the settlement of the land revenues and the limitation of the State demands to terms of years, the supplying of adequate instructions to district officials, the repairs of existing tanks for irrigation, and the restoration of once useful public works, the repairs of old, independently of the construction of new, roads, the sanitary condition of the large towns, the organisation of the Courts of Justice, the prevention of corruption and other malpractices, the enforcement of legal decrees, and the gradual habituation of all classes to respect and obey the laws."

Hyderabad was fortunate in possessing a Minister capable of carrying out such wide and far-reaching reforms. Sir Salar Jung was a man of remarkable ability, who for many years had held the post of Minister under the last Nizam, and, being himself one of the nobles of the State, was thoroughly acquainted with the wants of the country and with the defects of the administration. With the sympathetic support of the Government of India he applied himself to the task before him and succeeded during the Nizam's minority of fifteen years in accomplishing most, if not all, of the required measures of reform. Meanwhile the education of the young Nizam was a matter of great concern to the Government of India, and in 1874 a specially selected officer, Captain John Clerk, was appointed

guardian to His Highness and superintendent of his studies. The Nizam was invested with full powers of administration in 1884. Sir Salar Jung died in 1883, and was succeeded in the post of Minister by his son, Liak Ali, to whom the title of Salar Jung II. was granted by His Highness. This young man—though possessed of great ability—had not the tact of his distinguished father, and remained in power less than two years. Sir Asman Jah was Minister from 1886 to 1893, when he was succeeded by his cousin, Sir Vicar-ul-Umra, who held office till 1901, when the present Minister, Maharaja Sir Kishan Parshad, a descendant of the Peshkar and Minister, Chundoo Lall, was selected by the Nizam for the post. The politics of Hyderabad for the last twenty years may be defined as a series of continuous efforts on the part of successive Ministers to assert themselves in opposition to the Nizam, their ultimate failure and overthrow; and the eventual determination of His Highness to rule his State himself. This, he is perfectly capable of doing, for—as I found during the five years I spent as Resident at his Court—he is, by far, the shrewdest man in his State, thoroughly alive to the responsibilities of his great position; and one whose word is to be relied on.

The condition of Hyderabad has improved greatly during the past forty years. The revenues have increased from about one million sterling in 1868, to more than three millions in 1907. Seven hundred and forty-two miles of Railway have been constructed by the Nizam's Guaranteed State Railway Company. Vast sums of money have been judiciously expended on irrigation by competent English engineers, on the repair of anicuts and channels, constructed hundreds of years ago by the ancient dynasty of the Hindu Kings of Vigaya-nagar. Over 1,800 square miles (or 6 per cent. of the total cultivated area of the State) are now irrigated. The Singareni coalfields, worked by the Deccan Mining Company for the last 25 years, now give an annual out-turn of 450,000 tons of coal. There are 3 spinning and weaving mills, and between 60 and 70 cotton ginning and pressing mills in the State. Survey and settlement of land revenue has been carried out in 14 of the 17 districts. The Judiciary has been placed on a sound basis. In 1870, Sir Salar Jung appointed a Committee of Mohammedan lawyers to frame a code of law which, while based on Mohammedan and Hindu law, incorporates as far as is desirable the provisions of British-Indian Acts. There is a High Court at Hyderabad, and 123 Civil and 271 Criminal Courts in the different parts of the State. The police have been reorganised by an experienced officer, whose services have been lent by the Government of India. There is a force of 44,000 police in the districts, and 3,000 in the city of Hyderabad. The army has been brought under good discipline and control. The regular forces, including two fine regiments of Imperial Service Cavalry, number about 8,000 men, and are commanded by Afsar-ul-Malk, who holds the rank of honorary major in His Majesty's Army, a fine soldier, who has served with distinction in our army. In 1869 Sir Salar Jung initiated a State Educational Department. There are now three arts colleges, 2,669 schools, of which 16 are high schools, and 77 girls' schools. The last available return gives 90,000 boys and 4,900 girls under education. Hyderabad suffered severely from the famine of 1899-1900. The distressed areas and population were given in March, 1900, as 23,000 square miles, with $3\frac{1}{2}$ millions of inhabitants seriously affected, and 51,000 square miles with $6\frac{1}{2}$ millions partially affected. The Government of the Nizam met the demands for relief with great liberality. During July, 1900, the average daily number of persons in receipt of famine relief rose above half a million. To meet this expenditure and to provide funds for carrying on the administration the Government of India granted a loan of two crores of rupees (£1,333,000) at 4 per cent. interest, repayable by the State in annual instalments. The arrangement concluded with the Nizam by Lord Curzon in 1902, whereby the province of Berar was leased in perpetuity to the Government of India was a great achievement, for it cut a Gordian knot which had puzzled many administrations. The settlement, which was entirely satisfactory to the Nizam, has greatly facilitated the payment of this and other large liabilities. The financial position of the State, which has been its weakest point for many years, is now absolutely sound and satisfactory, and there is every reason to hope that Hyderabad is entering upon a period of progress and prosperity.

Mysore.

The Mysore State, which was restored to its ancient Hindu dynasty in 1799, after the death of Tipu and the capture of Seringapatam, was taken under the direct

administration of the Government of India in 1831, in consequence of a course of misgovernment which culminated in the rebellion of the subjects of the Maharaja. After 50 years of British administration the State was restored in 1881 to the deposed Maharaja's adopted son, His Highness Sir Chamarajendia Wadiar, G.C.S.I., under a deed of transfer which laid down conditions for the future relations of the State with the British Government. The Maharaja, who was a most enlightened ruler, died in 1894, and was succeeded by his eldest son, His Highness Sir Krishnaraja Wadiar, G.C.S.I. In 1902 the Maharaja was formally installed by the Viceroy, Lord Curzon. The post of Diwan had been held for eighteen years by Sir K. Sheshadri Iyer one of India's most distinguished statesmen, who to the great loss of the Mysore State retired on account of ill-health in 1901, and died in the following year.

When the State was handed over to its native rulers in 1881 the administrative system had been brought up to the standard obtaining in British provinces, and that standard has been, on the whole, worthily maintained.

Financially the State has been highly prosperous, in spite of expenditure on plague measures in 1899 and the following years, and some outlay necessitated by seasonal failure. The revenue of Mysore at the rendition in 1881 was about one crore (£666,000); it is now more than two crores (£1,333,000). The ordinary expenditure, which includes an annual payment to the British Government of £233,000 for the military defence of the State, has been generally far less than the income, and the substantial surplus has allowed the Durbar to enter into a policy of large public works. The discovery of gold in Mysore led to the grant of mining leases to several companies, and I need not remind my audience of the success of the Mysore mines, or of the enormous output of gold during the past 15 or 20 years. The State's receipts under mining leases have increased from £34,000 in 1891 to over £100,000 last year.

There are 450 miles of open railway belonging to the State, besides 56 miles of the Bangalore branch of the Madras Railway. The total capital expenditure on the lines belonging to the State is about 1½ millions sterling.

Mysore may be acknowledged to be the model Native State of India. It had all the advantages of 50 years British administration, but the Durbar deserves the credit of maintaining the standard of government then introduced, and of carrying out many measures of progress, such as the development of mineral resources, the expansion of railways, and the promotion of industries and trade.

The present Maharaja is a young chief of charming personality; he has received an excellent education, and since his accession to power, has given proofs of his desire to rule his State with prudence, and for the benefit of his subjects.

Kashmir.

Kashmir is one of the outposts of the Empire, for it spreads to the external frontiers of India, where the three empires of England, Russia, and China meet. It includes an area of 80,000 square miles, but the Jammu and Kashmir provinces, with areas of 5,200 and 8,000 square miles respectively, constitute the really important possessions of the State. The vast mountainous regions to the north of the valley of Kashmir include the districts of Ladakh, Baltistan, and Gilgit. The Chitral State is a feudatory of Kashmir, and the States of Yaghistan, of which the most important are Chilas, Darel, and Tangir are also nominally subordinate to it, and pay a tribute of gold dust. The story of the progress of Kashmir has been recorded in a most fascinating and interesting work called "The Valley of Kashmir." This book is a classic, and its greatest value lies in the fact that it was written by Sir Walter Lawrence, who as Settlement Officer initiated and personally carried out those reforms in the methods of assessing and collecting revenue which were so sorely needed. He not only succeeded in assuring to the State a gradual expansion of its revenues, but he freed the country from a system of forced labour (corvée) and the exactions of a corrupt and tyrannical method of collecting revenue which for many years had been the chief blot in the administration of this beautiful country. He has earned the gratitude of the State; and of the agriculturists, whose condition has changed from one of grinding oppression, to contentment and prosperity. He fostered the silk industry which has, of late years, expanded to such an extent as to bring to the State a very large revenue, and he gave an impetus to the cultivation of fruit, hops, and grapes, which promises to give the best results.

Trade with India has been greatly developed. The value of the merchandise, exported from Kashmir, has risen from £398,000 in 1891-2,

to £893,000; and that of imports from India, from £438,000 to £825,000. The revenues of the State have increased from £240,000 to £650,000.

There is only one line of railway in the State at present: viz., from the frontier near Sialkot to Jammu—16 miles long—constructed by the Durbar; it cost £64,000, and was opened in 1890. But there is a project for extending this line to the Kashmir Valley. Surveys for this extension have been made, and the estimated cost is about one million sterling. It is eminently a scheme to be supported by English capital; and those who know Kashmir and its prospects may confidently commend this enterprise to their friends in the City of London.

A most interesting experiment is now being carried out by His Highness, the Maharaja of Kashmir, under the immediate direction of Major Joly de Lotbinière, R.E., who has established his reputation, as an electrical engineer, by his admirable work in Mysore. This consists in the dredging, by electrical power, of the bed of the river Jhelum, where it leaves the valley of Kashmir at the outlet of the great Wular lake. The object of this scheme is three-fold. In the first place it is hoped that by opening the channel the danger of floods in the Jhelum which have so long been a source of danger and destruction to the valley and to the town of Srinagar, will be permanently obviated; secondly, that the drainage will reclaim 100,000 acres of marsh for cultivation; and thirdly, that more than 200,000 horse-power of electric current will be provided, which, after lighting the town of Srinagar, and working the silk, wood, and oil factories, the railway, and other concerns which are in contemplation in the valley, will still have for disposal and for use in the Punjab more than 100,000 horse-power of electric current.

I think you will agree with me that there is evidence of progress in Kashmir.

Concluding Remarks.

In the foregoing remarks I have referred to States of which I have some personal knowledge, but there are many others, such as Baroda, Cutch and Kolhapur, and the principalities of Kathiawar, under the government of Bombay; the Punjab States; and Cochin and Travancore in Madras, in which equal, perhaps greater, progress has been made during the last forty years.

If we look for the forces which have been brought into action, I think we may take the following as the most powerful. In the first place, I would put the example set by British rule. It is impossible to conceive that Native States could continue for all time in a condition of stagnation, while the Government of India was prosecuting a vigorous programme of expansion and improvement in all directions around them, and it is undoubtedly the fact that the chiefs have been roused by the example set before them. Next I would place the extension of communications by rail and road, and the manner in which Native States, so long isolated, have been brought into communion with the rest of India. Then we must remember that, during the period under review, a considerable number of States have, for various reasons, been placed under the direct management, or supervision, of British officers, and the higher standard of administrative efficiency thus brought about has been maintained, more or less, by the chiefs when they assumed power. Another powerful motive towards progress has been the education of the chiefs themselves. Forty years ago there were but few chiefs in India of whom it could be said that they were in any sense educated. There is now an entirely new generation. The Nizam of Hyderabad, the Maharajas of Mysore, Baroda, Gwalior, and Rewa, have been specially trained by private tutors and guardians during their minority. Other chiefs, such as the Maharajas of Jodhpur, Alwar, Bikanir, Kota, Kishengurh, Dholpur, Rutlam, and the Nawab of Jaora, have been educated at the Chiefs' Colleges at Ajmir and Indore.

Among the incentives to improvement may be reckoned the encouragement and assistance consistently given by the Government of India to every State that evinced the slightest tendency towards establishing an improved administration. This assistance has been manifested by large advances of funds, by placing at the disposal of the chiefs the best officers available as experts to carry out survey, settlement, and assessment, irrigation, public works, the conservancy of forests, and the establishment of a sound system of finance. Lastly, I would note the immense power exercised over the minds of chiefs by the interest in their welfare taken by the Royal Family of England. The visits of His Majesty the King when Prince of Wales, in 1875, and three years ago of their Royal Highnesses, the Prince and Princess of Wales, have done much to evoke the loyalty of the chiefs and to stimulate their anxiety

to prove themselves worthy members of the Empire of India. The speech made by H.R.H. the Prince of Wales at the Guildhall on his return from his visit to India is still ringing in our ears. We recall his appreciation of the loyal reception accorded to him and the Princess in all parts of India, and more particularly their gratification with the demeanour of the native rulers, and the hospitality and cordiality of their reception in the various States they were enabled to visit during their tour. If their Royal Highnesses were gratified with their visit, we may be sure that the people of India rejoiced in the honour of seeing the King's son, and that the advantages of the Royal visit were perhaps more strikingly evidenced in Native States than in any other part of the Indian Empire.

I now turn to the consideration of the manner in which, particularly of late years, ruling chiefs have evinced a desire to enter more largely into the Federation of the Empire. The traditions of Rajputana, which may be called the home of the great chiefs of India, as distinct from the principalities which have been created from Mohammedan, Mahratta, and Sikh conquests, point to a feudal system established for many centuries, which has been retained to this day with undiminished force. A Rajput chief is not only the ruler of his State; he is also the head of the family to which his feudatories and all members of his clan, high or low, whether they be princes of the blood or peasants of the soil, belong. Times have changed, and are changing year by year, but many, indeed most, of the principles, customs, and manners of the ancient Rajput clans are maintained to this day, and are clung to by chiefs and people with a tenacity which is the strongest evidence of their pride of ancestry, and their glory in the achievements of their forefathers. The government of Native States has always been autocratic. The Ruler's word is law, and from time immemorial the people have been accustomed to regard their chief as something very little less than a Deity; and so strong, so innate, is their sense of loyalty that, as we have seen in more than one unhappy case, they have submitted without a murmur, and for many years, to cruelty, tyranny, and oppression, during periods of the chaotic misrule of a misguided, or even an insane, chief. But, as it is said in India, "the subjects make the State," and in every chiefship the main principle has been to follow the lead of the Ruler. The natural tendency to retain the old-established feudal system has permeated all Rajput chiefs and it is, therefore, not surprising that after the establishment of the suzerainty of the British Crown in India, they should regard the Sovereign of England as their feudal Lord. It is this sentiment that has tended so much to weld the States of India into the Empire of England. And here I will quote from a speech delivered by the Maharaja Scindia on the occasion of the visit of the Prince and Princess of Wales to Gwalior, in 1905. His Highness said:—

"Whatever useful work has been, or is being undertaken in the various Departments of my State, has but one ultimate goal—to help towards the stability of the British Empire, and with that end in view, to ameliorate the condition of the people over whom I am called to rule."

I think in this brief sentence, Maharaja Scindia voiced the feelings of all his brother chiefs.

But it is not by words alone that the chiefs of India have declared their loyalty and devotion to the Crown of England. I have already alluded to the attitude assumed by our feudatories during the troublous times of 1857. Since those dark days there have been occasions, of which they have not failed to avail themselves, of showing their determination to support British rule in India. In 1885, when Russia loomed large on our North-West frontier, and the chances of war were more than probable, His Highness the Nizam of Hyderabad came forward with the spontaneous offer of a vast sum of money. This example was immediately followed by a number of the great chiefs of India, and although Government found it impossible to accept a monetary contribution the loyalty of the chiefs was allowed to find expression in another form which was, perhaps, even better and more effective. A force of 18,000 men, cavalry, infantry, and transport, known as Imperial Service troops, has been brought into a state of efficiency. This force belongs to the States and is commanded by their officers, but it has been assisted in training by specially selected officers of the Indian army lent for the purpose, and is now equipped and armed ready to take its place at any moment side by side with the armies of the King Emperor in the defence of India. It is maintained as a voluntary act of devotion to the Crown by 23 of the chiefs of India, and it forms, I venture to say, striking evidence of the desire of the chiefs to associate themselves and their troops with Imperial defence. When there was

trouble on the frontier of Kashmir in 1892-4 the Imperial Service troops of His Highness the Maharaja took the field and acted gallantly throughout the campaigns with the unruly tribes of Hunza, Nagar, and Chitral. During the war in Tirah, troops and transport of the Imperial Service of Gwalior, Kapurthala, and other States, took an active part, and bore their share of the fighting. During the war in China, in 1901, Maharaja Scindia, at very great cost, provided an equipped and well-fitted hospital ship, and proceeded in it himself to the seat of war, serving on the Staff of the General Officer in command of the troops. The Maharaja of Bikanir and Maharaja Sir Pratap Singh, then of Jodhpur, also proceeded on service, and proved themselves worthy soldiers of the King Emperor; and there were many chiefs who desired to join in the campaign but were dissuaded from doing so on account of the importance of their duties in their own States.

The first stimulus to the growing feeling of a desire to enter into closer relations with the Empire was given to the chiefs of India at the Imperial assemblage held by the late Lord Lytton as Viceroy of India in 1877. "Then," as one of our most distinguished Political Officers wrote at the time, "Chiefs who had not met on any previous occasion, and whose ancestors had met only in the field of battle, were brought together to realise the importance of their position as pillars of the State." The pageant of 1877 was repeated on a far grander and more magnificent scale in the Durbar, at Delhi, held on the 1st January, 1903, by Lord Curzon, when the Coronation of King Edward VII., Emperor of India, was celebrated with all pomp and ceremony before that vast assemblage of the chiefs of India and the representatives of all sections of the Indian Empire.

The tendency of late years has been to carry out in our relations with the native chiefs of India a policy of union, in contradistinction to the policies of non-interference and isolation which were so rigidly pursued during the first half of the nineteenth century. Lord Mayo was the first Viceroy who visited Native States during the tenure of his office, and in his day the difficulties of travel were so great that he could do little more than summon the chiefs of Rajputana to meet him at Ajmir. But so great was the esteem in which he was held that after his death from the knife of an assassin in the Andaman Islands in 1872, the chiefs of Rajputana raised a memorial to him in the form of the Mayo College at Ajmir, which has since been the means of affording education and training to a large number of chiefs, and which, under a reorganisation carried out by Lord Curzon, promises to bring forth in the future far larger results and far wider benefits than it has ever yet attained. In this connection it is interesting to note that Lord Curzon's suggestion of a committee of ruling chiefs to frame regulations for the future guidance of the Mayo College met with a hearty response and was in every way a great diplomatic success. On this occasion the chiefs of Udaipur, Jaipur, Bikanir, Gwalior, Rewa, and others, met in conclave, and in all good fellowship and harmony, evolved rules for the guidance of the education and training, as well as for social and religious observances of the young chiefs and nobles who are students at the college.

Lord Mayo's personal interest in the welfare of Native States has been maintained by each succeeding Viceroy. I remember in 1873 escorting the late Lord Northbrook through a part of Central India, where no railways then existed, and where roads were few and rough, on his way to Nimach and Ajmir. And year by year, as the means of communication improved, the Viceroys extended their tours in Native States; but Lord Curzon during his Viceroyalty visited all the important States of India, many of them more than once, and I am aware, as I had the honour of attending him during his tours in Central India and Hyderabad, how greatly he encouraged the chiefs, how effectually he stirred them to a proper sense of their duty to their subjects, and how deep and abiding was the influence he left with them.

I trust I have been able to show you not only that the administration of Native States has improved, and is improving, but that there is a growing desire among the chiefs to govern for the good of the Empire. I would not have it thought that I claim for Native States anything like perfection in their system of administration. On the contrary, I hold, and I think that all those who have served in Native States will agree with me, that much remains to be done. Yet there is a great deal to be said in favour of the personal character of government in Native States; it is in accordance with their traditions, and the principles enjoined alike by Hindu and Mohammedan religion, and, strange as it may seem, people do not wish to exchange the despotism of Native States for the more benevolent rule of British India.

We hear much in these days of agitation in India, and of the aspirations of those who call themselves the representatives of national thought and feeling; it is strange that, while so much has been said of the alleged shortcomings of British rule, no notice has been taken of the form of government prevailing in Native States.

And here it is that the advantages of autocratic rule assert themselves. He would be a bold man who would prosecute an agitation in any of the States of India, or would venture in the Capital of any State to criticise, far less to malign and traduce the actions or the intentions of the ruling chief.

DISCUSSION.

The CHAIRMAN (Lord Curzon), in opening the discussion, thought it would be the unanimous opinion of the meeting that they had listened to a very interesting paper on a most interesting subject. There were a great many things in India about which people in this country were very ignorant. He did not think they were indifferent; indeed, he believed that was almost non-existent with the spread of knowledge. But the ignorance about India was great and unabashed and at times appalling, and if there was a section of the Indian problem about which that ignorance more especially prevailed it was, he thought, the Native States in India. How many of those who talked about India as a great, dark continent, ruled by a handful of Englishmen, were aware that quite one-third of the whole area and more than one-fifth of the entire population of that Continent were ruled by chiefs of native blood, sympathies, and character? If that ignorance was as widespread as he believed it to be, what an opening there was for a lucid and illuminating paper such as that which had just been given. There was nothing quite like a Native State in India, either in its constitution, or in its picturesque and romantic aspect, in the world. The author had stated that the ruler was in his way a petty autocrat, almost a deity amongst his own people. And yet in that land of contrasts, as might be expected, the full prerogatives of sovereignty enjoyed by a native chief were, owing to his necessary connection with the Government of India, in many ways modified and curtailed. The same startling contrast was observable in the features of life in a Native State; indeed a Native State of the old type in India might almost be described as a paradise of contrasts, perhaps almost of paradoxes. There was in those States, particularly the States of Rajputana and Central India, a most strange and interesting blending of the old and the new, the archaic and the absolutely up-to-date, the aristocratic and the popular. The influence of astrologers and horoscopes was to be seen entrenched, so to speak, side by side with electric installations, and with the very best modern scientific institutions in which one's interior could be examined by the X-rays. In certain Native States, men in chain armour might be seen riding in the same procession as motor cars; while one might attend a combat of wild beasts in the morning and play a game of golf or polo in the afternoon. But the most characteristic feature about the States was that they were dear to the people of the country because they were racy of the soil. In the method of rule, in the family of the chief, and the system of feudality by which he was surrounded, there were symbolised the history of warfare, of rapine, perhaps even of crime, but, nevertheless, of chivalry and romance, with which for hundreds of years the State, the family and the people had been associated. To them the State summed up all that was beautiful, sacred, and venerable in the past; it was in fact the past projected into the present; and mad indeed would be the man who proposed to cut it out of the future. There was another respect in which the Native States endeared themselves to the people, and that was in the scope they afforded, greater in many respects than prevailed in British India, for the employment of native intellect. There a man felt he could rise from humble circumstances almost up to the highest, and opportunities were given to him which it would be in the highest degree unwise to abolish or curtail. Then, again, except in cases where the revenues of the State were dissipated by the chief, which was now much less frequent than it used to be, the administration of a Native State was, on the whole, decidedly less expensive than that which prevailed in British territory. Those were a few at any rate of the great advantages attending the system of Native States in India. In the earlier parts of his paper the author had given a most interesting, comprehensive, and accurate survey of the history of Native States from the beginning of the last century down to the present day. Was it possible to imagine a history providing a greater contrast between the condition at the beginning of that age and that reached at the end of it? He did not believe, in any civilised country at any rate, there had been so marked a change for the better, as in the condition of the areas to which he was referring. Whenever he wanted to find out what was happening in India in the old days he went to that most delightful of books, "The Rambles of an Indian Official," by Sir William Sleeman, written about 70 years ago; and he found that author remarked that in his time the majority of the Native States were either intriguing to devour the weaker, or were in terror of being devoured by the stronger, or of being devoured by the British. After those days, right up to the time of the Mutiny, mainly owing to the fact that the Company were essentially incapable of dealing with Native States, the latter were looked upon as a sort of vague and unmanageable menace, which it was wise to

keep weak because they might become dangerous if they were allowed to grow strong. The great turning point in the history of the Native States occurred after the close of the Mutiny. It was then that the Native States were for the first time brought into direct relations with the Crown; that was the starting point of the long advance which had been related by the author. Almost immediately afterwards came the historic action and policy, never he hoped to be departed from in the future, of Lord Canning. Lord Canning's action in abandoning the policy of annexation, and giving the right of adoption to the Native States practically insured, that unless there was a change of policy which it was impossible to contemplate, the continuity of the Native States, and of their ruling families, was secured. Was it possible to imagine anything more dear to the people themselves, or more calculated to stimulate their confidence in the Government which they acknowledged? Following on Lord Canning's day, the main steps in the forward march of the Native States seemed to him to have been, firstly, an act which was just mentioned by the author, but on which he thought perhaps more stress might have been laid, namely, the restoration of Mysore in 1881. He did not believe an act of that sort, the handing back of a Native State, which had been for fifty years under European administration, to a native dynasty, had ever been, or would ever be likely to be, carried out by any other European power than England. Then there were the two Delhi Durbars of 1877 and 1903. He agreed with the author in the belief that those great ceremonies did have an almost immeasurable effect in bringing the native chiefs of India into contact with the Sovereign on a most important occasion; while in addition they had the further advantageous consequence of drawing the chiefs out from their isolation, and enabling them to meet together in the same place; so that men who had never met before, and whose ancestors had perhaps fought with each other, henceforward became acquaintances and friends. The next step was the institution of the Imperial Service troops by Lord Dufferin and Lord Lansdowne in 1888 and 1889. Those who served with him (Lord Curzon) in the government of India would bear him out when he said that nothing gave them greater pleasure than when it fell to their lot, a few years ago, to employ those Imperial Service troops for the first time outside India. They were sent to China and to Somaliland, and then, for the first time, the salient fact was recognised that the princes of India were equally concerned with the Parliament of this country in the military defence of the Empire. Additional landmarks had been the institution of the Chiefs' Colleges and of the Imperial Cadet Corps. The result of all these proceedings had been that, although many of the States of India were still in a very backward condition, yet on the whole there had been a great forward and upward movement in the standards of administration; whilst one might even go further and say that, in respect of institutions such as modern hospitals, museums, and libraries, some of the Native States of India actually set an example to the Government of India. To what had that progressive advance been due? No doubt it had been to a large extent encouraged and stimulated by the confidence engendered by the policy of the British Government; but they must not fail to recognise that it had been in a large measure owing to the personality and character of the chiefs themselves. At the present moment amongst the leading chiefs of India there were a number of men of the highest character, and of remarkable ability, who in any country and at any time of history would have been fitted to be rulers, and worthy to be regarded as considerable rulers, of the States over which they presided. In the south of India, for instance, there was the Nizam of Hyderabad. He entirely agreed with what the author said about the personality of that excellent man. He was the shrewdest and ablest man in Hyderabad; he was further a most devoted and loyal adherent of the British Crown; and when he (the Chairman) had the good fortune to conduct with him the negotiations for the perpetual lease of Berar—negotiations which would never have been successful but for the author, who had great influence with the Nizam, although they were conducted without the slightest pressure being put upon His Highness—he carried away the most charming recollection both of the sagacity and the friendliness of that chief. A little distance away was Mysore, which was ruled at the present moment by a young chief of uncommon ability and promise, whom they hoped before long to welcome in this country. In Gwalior the present ruler was Maharaja Scindia, a most remarkable man, one, he imagined, of the few ruling potentates in the world who was equally capable of commanding a regiment or driving an engine. Indeed the Maharaja was a sort of steam-engine of physical and intellectual energy, because there was nothing in the State of Gwalior which the Maharaja himself did not originate, organise, superintend, and carry through to a final issue. In Rajputana was a chief who had visited this country, namely, the Maharaja of Jaipur, a man princely in character and beneficence, deeply devoted to the ancient traditions and customs of his country, and yet inspired with the highest ideals of modern administration. Then there was the Maharaja of Bikanir, a young man well known in England, of chivalrous bearing, a fine sportsman, with a perfect familiarity with English, and a devoted chief to his own people. It was, of course, impossible to go through the whole list of the chiefs, and he was merely taking a few of the more notable names. Proceeding to the Punjab, and the Phulkian States, there was as the leading ruler of that Confederacy, the Raja of Nabha, a noble and heroic figure, who would command attention wherever he appeared, and whose influence in the cause both of the good government of his own State and of the British connection was of inestimable value.

He had said that a great portion of the credit was due to, and must not be withheld from, the chiefs themselves. But, in the presence of a number of political officers whom he saw present, he desired to pay them the compliment of adding that he believed no small proportion of the credit was also due to them. It was quite true, as the author said, that a good deal turned on the political officer. Consider what the political officer had to do. He had in the first place to make friends with, and to acquire the confidence of, the chief; he must exhibit a warm sympathy with the etiquette and spirit of the native durbar; he must understand and make allowances for the environment of the chief and the circumstances in which he had been brought up. At the same time, while he did that he had to remember that he was the representative of the Imperial Government, and that it was his duty as such to exercise a check, where check was required, upon extravagance, maladministration or misrule. He might, therefore, at one moment have to appear as the intimate friend of the chief, and at the next moment as his monitor and mentor. It could be well imagined, therefore, what a rare combination of gifts was required for the successful discharge of those delicate duties. With a wise and tactful political officer there was no limit to the amount of influence he might exercise in the State; if he was harsh or overbearing, there was equally no limit to the amount of harm he was capable of doing. There was one ideal political officer sitting not far from him on the platform; if Sir Donald Robertson was present he was another, and possibly others were also in that hall. Any student of Indian affairs for the last quarter of a century would admit, that as the result of this sequence of capable political officers, criticisms directed against the action and interference of political officers were much less heard of now than was formerly the case. The services which many political officers had rendered to Native States in a period of minority should also never be forgotten. Some of the most flourishing of the States to which the author had alluded, and which had large surpluses devoted to developing the resources of the States and improving the condition of the people, would never have been in that position had it not been for the 10, 15, or 20 years during which they were under the guidance of men like Sir David Barr. He would go further and say that he believed if a proposal were made to abolish political officers in Native States to-morrow the first protest would come from, or at any rate the loss would be first and most immediately felt by, the chiefs themselves; they would realise in the majority of cases that they had been deprived of their wisest advisers and friends, that they had lost a means of communication with the Central Government by means of which they were always kept in touch with Calcutta or Simla, while the people of the States would also bitterly regret the disappearance of what was often to them a guarantee for good government and economical administration. There was only one other aspect of the Native States to which he would allude, but in his judgment it was the most important. The one problem upon which he looked with intense anxiety for the future of the Native States was the question of the education of the chiefs. The entire stability of the Native States did not depend on artificial conditions so much as it did upon the character and the training which was given to the chiefs, or which they assisted them to obtain for themselves. There was a passage in the paper which lifted the curtain of the past, and gave one a glimpse of the chief in the old days being brought up in the zenana, very often in the most corrupting and poisonous surroundings, where from the earliest years sychophants and time-servers obtained his ear. The result in many cases was the failure and disastrous collapse with which they were acquainted. All that had, he thought, gone. At the present moment three alternative systems of education were practically provided for the native chiefs. The chief might be educated by a tutor or officer, either native or European, in the State itself; and several of the best chiefs in India had had the advantage of that system of training. In many ways it had worked very well, but it had the drawback that, while it was in progress the chief was under the somewhat cramping influences of the State itself; he was not taken outside, and he lost the benefit of attrition with young men of his own class and rank which he might obtain in a college or in association with the larger world. Then there was the second alternative upon which the author laid some stress, namely, the system of teaching in the Chiefs' Colleges. Four of those colleges existed in the Punjab, in Kathiawar, in Rajputana, and in Central India; and they had, under the reforms which had been carried out in recent years, done their best to provide the young Indian noble or chief with an education which gave him all that there was of the best in Western culture, in the resources of Western knowledge, and in the principles of Western administration; while the manner and method of his life, his religious teaching, and a portion of the curriculum had been drawn up in accordance with the wishes of the chiefs themselves. On the whole, in his view, that was the best method of education that at the present moment was open to the native chiefs of India. Then there was a third alternative, which was to bring the young man to England and put him at an English public school. He should be sorry to say that that system was certain to result in failure, but he thought they ought to be very careful indeed in subjecting any of those young men to any influences however excellent in themselves, and however good for those who were of English blood and character, which might hereafter in the slightest degree tend to alienate them from the country in which their lot was cast, or the people over whom they might have to rule. By all means let them have the familiarity that he had just referred to with the structure of English politics and the principles of English administration, but that should

not be done at the expense of the character with which they were born, and which it was their duty for the sake of their people to conserve. It would be a fatal thing if the most promising of men was turned into so much of an Englishman that he became too little of an Indian; because if he was too little of an Indian he could not possibly be a good chief in his own country, and he could not possibly do his duty to the people whom his origin, position, and circumstances might require him at a later time to rule. It was quite obvious from the remarks he had made that the third alternative was one with which he was not in much sympathy, and that he hoped it would be the policy of successive Governments of India, as it had been for many years past, to encourage the idea of giving to those young chiefs the best education possible in their own country rather than outside it. His remarks had been sufficient to show that, at any rate in his opinion, everyone present should express the hope that the Native States of India might continue not only to exist, but to flourish. They were not merely a picturesque, but a valuable element in Indian life, an element about which it would scarcely be an exaggeration to say that in it was involved to a large extent the stability of British rule in India. He would not himself add to the territory of Native States. The author in the concluding portion of his paper stated that in his experience the people who were living in Native States would not willingly go over into British territory. But the converse was equally true, and the author would himself be the first to acknowledge it. Native peoples who had had the advantage of living in British territory would not willingly go back to a Native State. He had an opportunity of discovering that when he was endeavouring to effect an interchange of territory between Great Britain and one of the most important States in Southern India. The negotiations were proceeding satisfactorily; there was to be a certain interchange of villages and lands, but when it came to the point, none of the villagers in British territory would go into the Native State, and the whole thing fell to the ground. If both parties, therefore, were satisfied, if the people in the Native States did not want to come into British territory, and if those in British territory did not want to go into native territory, was not that a convincing argument for maintaining the *status quo*? Let them keep the *status quo*, let them preserve the principle of the Native States, but while preserving it, let them do everything they could to make their administration pure, progressive and strong, everything they could to give the chiefs the highest and the best education that would adapt them for the service they had to perform. While speaking of the native chief it must be remembered that he was of like character and ambitions with ourselves, that he could not be left to rust in his palace with nothing whatever to do, and that one of the foremost duties of the British Government was to find a scope for his energies, his ardour and his patriotism. Above all British administrators must remember and the chiefs understand that the two were rowing in the same boat in India. The chiefs were rulers of one part of the country, the British were rulers of the remainder, but the two partners ought to act in observance of the same principles, and in absolute harmony and co-operation with each other. If those were the principles which they continued to observe in the future, as he believed they were observing them now, then he thought the Native States of India would not merely survive, but would grow even stronger from year to year, and he was certain that if any emergency ever arose in which this country might have to call on them and their rulers for aid, we might rely with the utmost confidence upon their loyalty and devotion.

Mr. J. D. Rees, M.P., said it was quite true, as the author and the Chairman had said, that the Native States were satisfied and contented, and that a great change in their government was not required, but he thought a distinction ought to be drawn between the Native States which were under the control of the Government of India and those under the control of Provincial Governments. The author had reviewed the position of the different Native States, under the Government of India, and called attention to how advanced and well administered they were, but hardly any notice had been taken of a political charge which was not only far in advance in point of education of everyone that was mentioned, but far in advance of any part of British India, viz., Travancore and Cochin. These States, the third largest in population and the fourth largest charge in revenue of all the States of India, hardly attracted any attention on the present occasion because they were under the control of a local Government. While the great Native States received their British Residents from a service specially recruited for the purpose, the other States were a sort of prize for the ordinary officer in the ordinary line of business, whose one idea was to make the government of the State similar to that which he administered, as head of a department. In that way he destroyed the individuality of the State, which was one of the chief objects of the preservation of the States. If that was the case with the Resident, how much more so was it the case when the rulers of the States were advised not to appoint as their ministers gentlemen of their State, who naturally would be recommended by the ruling chief if his initiative was wholly respected, but somebody from outside, who, during the whole of the time he was administering the State, kept his eye on the neighbouring British Government in the hope of subsequent promotion after he returned. He submitted that it would be worth the while of the Government of India to reconsider the position in regard to those States, for the purpose of ascertaining whether any of them should not be taken away from the Provincial Governments, which regarded the Residentships as mere prizes for seniority, and thus confer on them the ad-

vantage of being assisted by a political officer who was comparative in his knowledge, and had no object in destroying the individuality of the State. It must be gratifying to gentlemen like Mr. Hyndman, who were always calling attention to the fact that the Native States were very much better administered than British India, to know that the first appointment made when an Indian gentleman was appointed to the Secretary of State's Council was that of Mr. Saiyad Husain Bilgrami, who spent the whole of his service in a Native State. He hoped no further criticisms would be received from the Congress section, which ought to be delighted that an Indian gentleman, so exceptionally fitted for the post had been appointed.

Mr. Saiyad Husain Bilgrami, C.S.I., thought the points to which the author and the Chairman had directed attention were of the utmost importance, and he was very glad that such matters were being brought to the notice of the English public. There was a phenomenal ignorance (not from any want of kindly interest and sympathy) in England of the affairs and people of India, more especially the latter, which would soon disappear if papers like Sir David Barr's were more frequently read in this country. It was a very happy thought of the author's to take only the last forty years of the life of the Native States, because their awakening did not date very far back, and the sympathetic treatment they now met with was only a modern feature; in former days, especially in the days of the East Indian Company, they were quantities that were generally neglected. Only within the last few years had the Native States begun to realise that they were treated like friends, and to that feeling Lord Curzon more than any other Viceroy had given currency. He knew from personal experience that his lordship had done more than anybody else to attract the native princes towards the central Government, to make them feel that they were not aliens, but were trusted and treated as co-partners in that joint stock company which was called the Government of India, in the management of the Indian Empire. One of the results of that treatment had been that he did not think in the whole of the Continent of India there were people more loyal to the British connection and to His Majesty the King of England than the rulers and people of the Native States. As a result of that confidence, and of the improved methods of education which the Central Government had extended to the native princes, the administration had improved considerably within the last twenty-five years; and there was such a vast difference between the character of the Government now and thirty or forty years ago, that it was hardly conceivable. Within his own knowledge, he could testify to the vast change which had come over the State of Hyderabad, which was now one of the most progressive in the country, one that satisfied the wants and aspirations of the people, and where the Sovereign was one of the most loyal and faithful allies of the British Crown, and beloved by his own people. That was indeed a character which was shared by all, or almost all, the native princes of India, including His Highness the Nizam, the Maharaja of Baroda, the Maharaja of Mysore, the Maharaja of Bikanir, and others; they were loved by their subjects. Even those rulers who in the old days were guilty of misrule, or who because of eccentricity or some other cause did harm to their own people, were excused by them. His Highness the Nizam was, without doubt, after the great administrator, Sir Salar Jung—the greatest statesman in the State—the ablest and shrewdest man among the people of Hyderabad; indeed, he might venture to say the ablest member of the ruling family which began with the famous Asab Jah. There was progress in the State all along the line, a progress that promised to continue; and he hoped and prayed that God would give long life to the present ruler so that he might go on with the progress which he had begun. He thought it would be of interest if he stated that out of the four Residents in Hyderabad who had led to the excellent understanding which now existed, two were present at the meeting, Sir Steuart Colvin Bayley and the author; the other two being Sir Dennis Fitzpatrick and Mr. Jones. He was sure he was voicing the feeling of the whole audience when he said they owed Sir David Barr a deep debt of gratitude for his paper, and as much to Lord Curzon for the excellent speech he had made.

Lord Lamington thought there was a very great deal of truth in the remark Mr. Rees had made, that there was a tendency on the part of the Civil officer when he was appointed to a Native State to take too great a share in its control and try to level up the administration to what pertained in British India. Amongst the problems that continually beset the administration in India was that of how far one intended to demand efficiency. The Government was strictly bureaucratic, and local administrators were apt to be found fault with if they did not see there was a proper method in existence, and that rules were obeyed. Bombay, unlike Madras, had its own political department, and was, therefore, perhaps, free from those evil features to which Mr. Rees referred; and he was happy to think that that Political Department, of which the Chairman did not always approve at times, had been improved both in regard to pay, and in a certain degree in regard to its members. He referred to the point because all were anxious to preserve the identity of the Native States as such, and it was not wise to expect too much from them or try to bring them up to one level, as was found in the administration of British India. A good deal could be done by encouraging the rulers themselves to adopt the methods followed by the administration of British India; and it

was there that the personality of the political officer came into play.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Sir David Barr for his excellent paper.

Sir STEUART COLVIN BAYLEY, in expressing the thanks of the audience and that of the Society in general to Lord Curzon for his kindness in presiding, said it was no small thing for a statesman of his lordship's many interests, whose nights were devoid of ease and whose days were spent in labour, to devote the necessary time and attention, not only on the present but on many previous occasions, to presiding. It was by means of such a paper as Sir David had given, and the Chairman's illuminating remarks upon it, that the aims and objects of the Indian Section were carried out. The Section was founded with the main object of introducing to English people a better knowledge and understanding of Indian ways and ideals; and nothing could be more likely to help in that object than the presence in their midst of a statesman of Lord Curzon's calibre.

Colonel C. E. YATE, C.S.I., C.M.G., late Chief Commissioner of Baluchistan, writes:—

All old Indian political officers who, like myself, heard Mr. Rees's remarks will, I think, have been in sympathy with the principle of non-interference in the internal administration of Native States, but there was no time left to discuss the subject, and I think it should be understood that Mr. Rees's remarks as to what he called the collectoratising of Native States were based on his own experience in Southern India under the Government of Madras and do not necessarily apply to Native States in more northern parts of India. In Madras there is no regular Political Service, and any Civil officer may be posted as political agent to a Native State, just as Mr. Rees himself was appointed to Travancore and Cochin, and the desire to bring the administration of Native States into line with that of the British districts may be more general there than elsewhere.

The vast improvement that has taken place in the administration of Native States throughout India since the days of the terrible famine of 1868, which was my first experience of Rajputana, was ably dwelt upon by Sir David Barr, and the evidences of continued progress that he adduced are solid facts that cannot be controverted. That the total revenues of Rajputana and Central India have expanded by more than 60 per cent. during the past 40 years shows of itself the beneficent results of British supervision, and is evidence that the chiefs themselves have been roused by the example set by British rule. Sir David Barr bore testimony to the encouragement and assistance given by the Government of India to the Native States by advances of funds and by the placing at the disposal of the chiefs the best officers available as experts to carry out survey, settlement, assessment, irrigation, public works, forest conservancy, finance and other things, all of which has had such excellent and remarkable results; still the political officers who remember the feudal system of government in Native States in our younger days, the hereditary system of service in the State that then prevailed, and the old hereditary officials, do not wish to see these latter ousted by outsiders from other provinces, and we certainly do not wish to see the introduction of sharp pleaders and others learned in the law from British districts, or the general introduction of a British system of administration. I remember when I was first posted to a Native State, in 1871, I was a subaltern, fresh from my regiment, without the slightest knowledge of law, or of civil administration, and it never entered my head to question or interfere in the details of internal administration of the State. A civilian who has administered a British district of his own, on being posted to a Native State as political officer, is naturally tempted to interfere when he sees things going differently from the way in which he was taught to see them go, and I can well understand the preference shown in former days by native chiefs for military political officers rather than civilian. Nowadays all political offiers, whether military or civilian, are more or less trained to civil administration before being appointed to Native States, and the difference between the two services is not so marked. All the more care is, therefore, necessary to guard against undue interference with internal administration.

Personally, I do not advocate the introduction of British settlements, British assessments, and other forms of British administration into Native States. I do not as a rule favour the lending of British officers to Native States for the carrying out of internal administration; and should native chiefs be desirous of improving the administration of their States I would prefer that they should depute their own native officials, *boná-fide* natives of their own particular State, to learn the British system in a British province and then to apply that system in their own method, rather than that they should import British officers to apply it for them. Sir David Barr wisely dwelt on the advantages of the personal character of government in Native States, but once you introduce the British Government officer the personal rule of the chief is apt to wane. The direct personal rule of the chief is, as Sir David Barr said, in accordance with the traditions of Native States and with the principles enjoined by the religion of both Hindu and Mohammedan alike. Let, therefore, as little interference as possible with the personal rule of the chief and the grant to him at the earliest suitable moment of the fullest possible powers be the leading maxim of political officers in their relations with Native States throughout the length and breadth of India.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 18th, 1908; the EARL OF PLYMOUTH, C.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Buckingham, Sir James, C.I.E., Lorrenden-lodge, Beddington, Croydon, Surrey.
Fairbairn, Rev. Principal A. M., D.D., LL.D., Mansfield College, Oxford.
Gower, R. Vaughan, Ferndale-lodge, Tunbridge Wells.
Meldon, Major James Austin, Windham Club, 13, St. James's-square, S.W.
Mody, Ardeshir S., 11A, Harrington-gardens, S.W.
Outram, Rev. Arthur, Little Heath Vicarage, Potters Bar, Herts.
Reinhold, Gustave C., Assoc.M.Inst.C.E., 11, Hervey-road, Blackheath, S.E.
Salahuddin, Khan Bahadur Kazi, Nandura Nemgaon, Buldana, District Berar, India.
Sharma, Pandit Umapatidatta, B.A., 1/1, College-square, P.O. Bowbazar, Calcutta, and Chilehri, P.O. Manjhawari, Arrah, India.
Shore, Joseph, J.P., Cinnamon-hill, Little River, Jamaica, British West Indies.
Trotter, Lieut.-Col. Sir Henry, K.C.M.G., C.B., 17, Chester-square, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Aird, James Erskine, Deundi Tea Estate, Lalchand P.O., Sylhet, India.
Eldridge, T. J., care of Imperial Maritime Customs, Shanghai, China.
Gascoyne, George, 83, Charlwood-street, S.W.
Gee, Charles Douglas, Assoc.M.Inst.C.E., office of 1st Division, Lower Bari Doab Canal, Lahore, Punjab, India.
Hanson, David, Salterlee, Halifax.
Keates, William Francis, Cannelton, Indiana, U.S.A.

The paper read was—

IMPRESSIONIST PAINTING: ITS GENESIS AND DEVELOPMENT.

By WYNFORD DEWHURST.

The subject of Impressionism is one which I have much to heart and with which I have for the past twenty years been closely associated. It is a subject which, I think you will agree, requires wider ventilation and consideration than has hitherto been accorded to it in this country. An injustice remains to be righted, and men of superfine talent and grand achievement—foreigners though they be—still await that degree of respect and approbation which is undoubtedly their due, and which English people, when once the true facts are placed before them, will not be slow to grant. England is, strange to say, the only civilised nation which has steadfastly refused to recognise the claims of the school of painting which it is my privilege to interpret and champion. Even the Barbizon school of painting, for sixty or seventy years ostracised, is only just now beginning to make its presence felt in our public art galleries and museums. Truly, in the matter of æsthetics we are a slow moving people.

Many here present will remember that, during the "eighteen-eighties," art was much to the fore in this city. Our schools and societies, clubs and coteries, dealers and galleries flourished exceedingly; whilst, at that time also, our annual exhibitions attained their maximum of importance and influence. Hundreds of thousands of eager visitors thronged their charmed portals, and thousands of pounds sterling were yearly exchanged between art lover and art producer. Those years were, it seems to me, the millennium of the arts in England, and incidentally, I am convinced that time and a regeneration of taste now proceeding, will see their happy return. There was, however, one phase of manifestation in paint which found neither place nor honour here; which was, in fact, banned by all and every, simple and *savant*.

Not a single picture, to the best of my belief, of the school of painting to which I allude, was ever exhibited in our great public galleries, so that, the artists being effectively muzzled, the people were denied even the opportunity of viewing their productions. There was no chance given of forming independent opinions and consequently ignorance of the subject was rampant, even in otherwise well-informed circles.

If the Press by hazard mentioned the school it was more frequently than not either in condemnation or in ridicule; happily an entirely friendly spirit now prevailed. Now the name of this particular form of painting was "Impressionism." To be labelled "Impressionist" was, in those days, surest sign of an artist's unpopularity and surest and quickest route to poverty and obscurity.

Possession of an Impressionist picture was held to denote eccentricity greater even than in he who should fling his purse over the Tower-bridge and expect to net bank-notes in return. So it was, therefore, that imbued with

this same universal spirit of hostility to a form of art I had never seen and against men whose names even I knew not, that I travelled abroad, and, to my everlasting surprise right into the camp of the enemy as a ready-made Impressionist, in embryo.

In Paris, I was confronted with the sight of some hundreds of pictures by various artists, all new and strange to me. From Sisley to Renoir, from Pissarro to Degas, and from Monet to Manet, I wandered with ever increasing admiration. 'Twas a veritable fairyland upon which I had chanced, and those days will be remembered as amongst the most remarkable of my life.

A few simple portrait and figure pieces, very evidently bathed in sunlight, by Manet, and some beautiful landscapes, by Claude Monet, particularly attracted me. These latter were pictures of haystacks, viewed and painted at different hours of the day and different seasons of the year. Some of them shimmering in full glare of noonday sun, others buried in snow or glistening with winter's rime. Moreover, there were pictures of ice-floes on the Seine, works whose brilliancy, power, and charm beggar description. Later on came the same artist's ever memorable poplars, Cathedral and Thames series of pictures, all of them poetic transcripts of evanescent-atmospheric effect. They moved me as no other pictures have ever done, before or since. I greeted them with enthusiastic joy, my whole being responding to their appeal, and thenceforward I knew myself as an Impressionist, in spirit at least.

Full of the ardour so spontaneously generated, I have since then lost no opportunity of enlightening others, for no man, says Southey, was ever yet convinced of any momentous truths without feeling in himself the power, as well as the desire of communicating it. I feel much as Ruskin did of the one time neglected genius of Turner, that in asserting and demonstrating the supremacy of the great masters of Impressionist painting, I shall do immediate service both to the cause of art, and the cause of righteousness.

And now the whirl-a-gig of time has brought me home to expound the faith within me, surrounded upon all sides by pictures from the brushes of the very men, whom, formerly, to name even, was sufficient provocation to raise a storm of invective and abuse—*autre temps—autre mœurs*.

You will all, I hope, agree with me in commendation of the taste and independence of the Manchester Art Gallery Committee which, in December last, brought to such successful issue the idea of a historical presentment of the bud, the flower, and the ripe fruit of Impressionist painting.

The complete genesis and development of the movement might there have been quietly and systematically studied, and I believe that that particular exhibition will mark an epoch in the art history of our country, and that its effects will be farther reaching than ever suspected by its originators. Art teachers and art students flocked to it from all parts of the country, whilst some scores of thousands of intelligent amateurs flocked hither as to a shrine.

Of course, not all of the impressionist pictures were there, not even the best of them, these have long ago been garnered by astute collectors throughout the world. Still, we had sufficient material upon which to base an estimation of the merits of the school, and so had cause to be thankful.

The same meed of acknowledgment and welcome must be accorded to the fine taste and independence of the Dublin Corporation which has recently established a gallery for the express purpose of exhibiting an important and rapidly increasing collection of Impressionist pictures.

There is not the slightest doubt but that the enviable precedent thus established will soon be followed by many another wide-awake municipality.

At this point may I ask those to whom the matter of Impressionist painting is entirely new and who yet desire enlightenment, to come to its study with minds disabused of prejudice. I ask you not to pay too much attention to the effect produced upon you by the manner in which some of these pictures are painted. Their quality of surface is apt to repel at first sight. Mere pigment, however applied, is but the messenger of the sentiment of the subject. A welcome missive is acceptable despite the manner of its conveyance, and "Gray's Elegy" will still charm though written in the veriest schoolboy's scrawl.

Bear in mind also that immediate appreciation is the gift of the few, and that the complete signification of Impressionist painting can only be conveyed to faculties already receptive and refined. Its consideration, therefore, demands that broad-minded spirit of criticism without which progress can neither be made nor expected. Come again and again to

study the pictures. Since *la peinture sent mauvais* it is well not to approach too closely the works under review. Given these necessary and none too exacting conditions, and you are assured of finding such new sensations and æsthetic pleasures in Impressionist painting as will fully recompense the time and effort given to its study.

Sir Joshua Reynolds did not hesitate to express his conviction that, in the future "so much will painting improve that the best we can now achieve will appear like the work of children," and we may hope that our power of enjoyment will increase in like proportion. Art helps us to see. Hundreds of people can talk for one who can see. To see clearly is, as Ruskin well says, "Poetry, prophesy and religion all in one." If that be so we ought all soon to develop into poets, philosophers and saints for no other form of art is so capable, I believe, as Impressionist painting, of opening our eyes to the feast of beauty so lavishly provided by Nature. Art was made for that:—

"For do we not love first,
When we see them painted
Things we have passed a hundred times
Nor cared to see.
So they are better painted
Art was made for that
God uses us to help each other so, lending our minds out."

"Impressionism," says Georges Lecomte, "is worthy our utmost admiration, and we can rationally believe that in the eyes of future generations it will justify this century in the general history of art."

That I hold to be perfectly true, and will now proceed to develop for you the grounds of my conviction. Let us hark back for a moment to beginnings—for there is a sequence of advance in the art of landscape painting as clearly defined as that which, in the sister art of shipbuilding, has led to the production of our Dreadnoughts and Mauretanias. Setting aside the art of antiquity, known only to us through names and fragments, we will pass in review the tale of the centuries from the thirteenth, the foundation of all recent art, the fourteenth, the age of thought, the fifteenth that of drawing, and the sixteenth, that of painting, glorified for all time by the masterpieces of Titian, Correggio, Tintoret, and Paul Veronese, we come to the days in which the landscapes of Claude, of Poussin and of Salvator Rosa revolutionised landscape painting. Those three men revealed a fresh outlook upon Nature, which, imperfect and meretricious as it was, conveyed a freer, more virile, and more complete idea of natural beauty than had hitherto been attained. For as you well know, in its inception, landscape art played a very inferior *rôle*, and appears in the picture of the ancients only as so much caricatured and conventionalised background, for the better display of religious subjects. Indeed to Claude undoubtedly belongs the honour of having been the first artist who ever thought of trying to render upon canvas effects of natural sunlight, or who ever conceived the idea that Nature unadorned might be worthy of study as an art apart.

Thus Claude, Poussin, and Salvator Rosa may be regarded as the inventors of landscape painting, which is, therefore, but a stripling of some two hundred and fifty summers. The accomplishment of those three pioneers is, however, incomparably inferior, from whatsoever point of view regarded, to that of our own countryman, J. M. W. Turner; the refulgence of whose genius has illuminated with undimmed vigour the art of landscape painting for the past century. In fact, he practically created the art of which he still remains the greatest master.

From 1773, then, being the natal year of that colossus amongst artists, dates all that is worthy of emulation in landscape painting. Now, since the greatest triumphs of Impressionism have been won on the field of landscape, it naturally follows that Turner and in less degree his friend, John Constable, are the true inspirators of the school. It derives from them as naturally and as easily as does the river from its mountain source, or the flowers of the field from the sunlit sky. Truly has time fulfilled Ruskin's prophecy, when he wrote of Turner that—"Every day that he lies in his grave will bring some new acknowledgment of his power, and through those eyes, now filled with dust, generations yet unborn will learn to behold the light of Nature. For who before Turner had lifted the veil from the face of Nature; the majesty of the hills and forests had received no interpretation, and the clouds passed unrecorded from the face of the heavens which they adorned and of the earth to which they ministered."

We shall presently see how France, through Turner's eyes, did awake to the beauties revealed by this same light of Nature, and how, through France, the world at large has been enlightened. Whilst, in England, Turner

and Constable were striving after light, and more light, ambitious to imprison the sun's very rays upon their canvas, their cross-channel neighbours were just as ardently engaged upon a system of painting of their own invention, and far removed in objective from that of the Englishmen. They resigned themselves to the impossibility of sunlight and atmospheric painting, and took refuge in obscurity. Incredible as it may seem to us, it is nevertheless a fact, that no artist's outfit in those days, be he figure or landscape painter, was complete without its little black convex mirror. Regarding the object to be painted through this instrument they in very truth rendered Nature as seen through a glass darkly. All the pioneer Impressionists even, at the outset of their careers painted in this manner, as their works attest, and Ruskin is not the only art critic who has noted the fact. In proof of this important point, pray regard when chance offers, any pictures by Delaroche, Courbet, Flandrin, Regnault, or Couture—who, by the way, actually started his pictures upon a canvas grounded in pure black. This obscurantist, Couture, was for six years Manet's professor, years marked by continual bickerings between pupil and teacher. All the more credit is then due to Manet for having so effectually emerged from the bituminous fog of his time and triumphantly led the van of sun worship in France.

Now, Manet was the recognised leader of the Impressionists from the year 1860 onwards, and the movement was the consequence of a schism which took place some fifty years ago amongst a certain section of French artists, young men of intelligence and high aspiration, endowed with great artistic capabilities. They believed that the principles upon which art was being taught in the schools of the period were wrong, root and branch, and that in consequence the pictorial output of those schools had become unworthy of France's best traditions. Therefore, throwing down the gauntlet, they set themselves the colossal task of proving their theories by convincingly putting them into practice. After super-human efforts, and with lapse of time, they succeeded and have actually transfigured not only the art of their own country, but that of every nation wherein art obtains.

The story of its doings is profoundly interesting. It is a history fraught with all the elements of a dozen thrilling novels, which for adequate treatment, requires both more imagination, more skill and more time than are at my disposal. Many bulky tomes, by gifted authors, have been published upon the subject, and to them I would refer those of my hearers who are specially interested. After perusal of some of these books they will, I feel sure, agree with Monsieur Theodore Duret, the Parisian connoisseur, when he states his belief "that nothing sadder can be found in the history of art than the long persecution inflicted in France upon its really original and creative artists." Deaths in the madhouse, from the suicide of despair, and from sheer starvation, have marked the progress of Impressionist painting, and rightly did Zola say from the bitterness of his own experience that:—The history of literature and art is a sort of martyrology which recounts the abuse that has covered every new manifestation of the human soul.

Baudelaire also was more than justified in writing that "Nations have great men in spite of themselves, as do families." They are not desired by either, so that the great man, in order to exist, must needs possess a power of attack greater than the force of resistance developed by millions of individuals. That is a law of Nature, yet evidently there must be an enormous waste of fine temperaments in the process, to the detriment of the State.

Poor Francis Thompson, late of the Owen's College, Manchester, and of this great metropolis, is a recent case in point. There went down a great spirit in despair whilst the world stood callous by.

France, ever in the van of enlightenment, is now foremost of the nations to recognise this culpable, nationally detrimental, waste of genius, and to attempt reform. Still, "Art will out," and we have cause to be thankful that it has been reserved for this generation to witness a quite phenomenal artistic revolution. We see the successful issue of a long acrimonious and desolating struggle between a small band of devoted painters and the world of prejudice and disdain.

The artists simply claimed freedom to propagate ideas such as have since so radically changed and enlarged the practice of landscape painting, and the right to live modestly by their talents and labours.

Yet for years those primal necessities even were denied them, and both they and their art would have perished of starvation had not a small body of intelligent critics and far-sighted friends come to their aid. With the conviction of true inspiration and for close upon half a

century those outsiders resolutely stemmed the tide of public obloquy. Happily a truce is now declared: the "Sturm und Drang" has subsided, and the world acknowledges that these artists have indeed something to show well worth the seeing. Eminent writers assure us that this movement alone, this group of most gallant painters, has more than justified their century in the tale of art achievement. Plutocrats compete for possession of their works at fabulous prices; the Luxembourg enfolds them *en masse*, enlarging its galleries for the purpose, whilst the Louvre itself has now its quota. We are therefore in the piping times of peace and goodwill, and appreciation is the order of the day.

I am frequently asked who and what are the Impressionist painters, and how can one distinguish an Impressionist picture. The answer to both questions is simple.

First, however, let me say that the Impressionists emanate from no school, and form no school, in the sense which implies master and scholars. On the contrary, being men of strong character and marked individuality, they must be regarded as independent coworkers in a common field of ideas and industry, banded by friendship and inspired by the same sentiments. Each one striving to solve the same eternal problems of light after his own manner.

Now this independent co-partnership forms one of the most characteristic features of the whole movement. Here we have men as dissimilar as Cézanne and Manet, as Sisley and Monet, Pissarro and Renoir, assiduously pursuing an ideal, without present hope of fee or reward, and in face of very evident public opposition and consequent physical privation.

At the outset of their crusade and for long years afterwards, those men were, with one single exception, minus friends and fortune, power in the State, in the Press, or in the mart. All that, and much more, had to be created, together with their art itself.

Surely it was no ordinary idea which could so irresistibly have moved them to such tremendous efforts and sustained them in their tribulations. Nor was it. Regard their pictures, for the proofs are there: the idea has crystallised and is at your service.

Now the pioneers of Impressionism are constituted much as the pioneers in any other vocation, They have been especially equipped by nature for the task which they have been moved to undertake. A casual glance at their physiognomies alone will amply suffice to prove that. They were strong men, physically and mentally, endowed far above the average with talent, and with that indomitable conquering spirit so necessary for original discovery and its development.

The following names are those of some of the painters, poets, and writers, constituting a remarkably talented *coterie* of men, who during the winter seasons of several years prior to 1870 nightly foregathered in the Café Guerbois, Paris, for discussion of a new manifestation in art, destined to be known in later years as Impressionism. In those days they were dubbed *l'Ecole des Batignolles*, from the name of the quarter in which their *café* was situated.

Of painters there were Edouard Manet, Claude Monet, Jongkin, Cézanne, Degas, and Fantin-Latour, whose life-sized painting of a group of the principal members of the club now adorns the Luxembourg Gallery. As time passed, came Harpignies, Pissarro, Henner, Alfred Stevens, Sisley, Raffaelli, Renoir, and many others.

Whilst busily at work outside, though ever under the direct influence of the clnb, were four of the most talented women painters who ever existed: Mesdames Berthe Morisot, a Parisian beauty, granddaughter of Fragonard, and Manet's sister-in-law, Marie Bracgremond, Eva Gonzales, and Mary Cassatt, an American.

Amongst the numerous literary men of talent, who also frequented the *café* and took part in its deliberations, were Emile Zola, Baudelaire, Gautier, and Duranty, joined from time to time by Theodore Duret, Gustav Geffroy, Arsène Alexandre, and scores of others. A truly brilliant constellation of genius, you will admit, and all for the upbringing of an art as fascinating as it was in the land of its birth despised—a veritable Cinderella of painting, as events have proved.

Now Whistler, commonly known in this country as an Impressionist, though not so on the Continent, occupies a place apart and outside impressionism proper. He can rank in the same distinguished category as Carrière, Pointelin, Alexander Harrison, and many another, as a painter of tonal values, whose effects are not got by the division of tones, and the juxtaposition of pure colour, but by flat tints of broadly applied palette mixtures. Whistler, so far as I know to the contrary, never even attempted sunlight painting; certainly, with his habitual sombre palette, such a feat would have been impossible. His use of paint and outlook upon Nature were

practically the negation of Ruskin's teachings, hence the great critic's anger, and, paradoxical as it may seem, it is not too much to say that, in their famous duel-at-law, Ruskin was the real Impressionist, and Whistler the philistine.

In order the better to illustrate this point and to set at rest much public uncertainty as to what does and what does not constitute Impressionist painting, I have brought here a few of my own pictures as examples. They are all painted direct from Nature. The two upon my right hand are true Impressionist paintings, the effect being obtained by the juxtaposition of pure tints of colour. Those upon my left hand, although complete, and I believe, correct impression of the corner of Nature then before me, are not, properly speaking, Impressionist paintings, but are tonal effects painted after the manner of Pointelin, Carrière, and Whistler. You will observe a vast difference in their technique. The higher in tonal value the effect to be obtained, culminating in direct sunlight, the more necessary it is to employ the method of division of tones; and the lower in tonal key, the easier it is to paint by the old-fashioned system of palette-mixed tints and flat brushwork.

The examples before you can be much better studied by daylight than by this artificial light, and they may be viewed for the next month or two under more natural and favourable conditions elsewhere in this city.

Pray, do not for a moment think that my especial laudation of Impressionism betokens a narrow æsthetic sympathy—for quite the contrary is the fact. Many other styles or conventions in paint exist, which claim my profoundest admiration and the Impressionist painters by no means exhaust the list of sterling artistic temperaments.

As Impressionism is a fine product of art which appeals only to the intellectual, so it requires for its successful manifestation, possession, in the highest degree, of the imaginative, analytical, and synthetical faculties, coupled with power to feel, and to express, the strongest spiritual motion and *élan*. Its object is to picture an abstract or *resumé* of the general aspect of things, rather than the mere photographic delineation of actual observed fact.

In a real Impressionist picture is found just that quality which is inevitably absent from the work of the mechanic in art. It embodies a comprehensive all-embracing glimpse of some chosen bit of nature, glorified in rare and beautiful atmosphere. The impression of some fugitive accidental effect, a poem in colour, an almost unbelievable vision of things transitory, seldom given to the ordinary mortal to behold and hitherto denied the greatest of landscapists to pourtray.

Impressionists endeavour adequately to realise the infinitely beautiful, ever-changing effects of atmosphere. They affirm the sovereignty of light and, if title be necessary, that of Luminist would better indicate their aims than that of Impressionist. True artists, and so these Impressionists are to a man, will not so paint a flower as to lose sight of the garden, or the twigs of a tree and miss the landscape. They have learned to represent the *ensemble*, to select, summarise, and to subordinate detail for the effect of the whole; to get at the pith of a scene, ignoring the thousand and one distracting elements of prolific nature, which puzzle and distract the average painter of things that are. As the wizard of the butterfly mark has observed, "To say to the painter that Nature is to be taken as she is, is to say to the player that he may sit upon the piano."

Impressionists are consummate draughtsmen, as innumerable portrait and figure pieces, etchings and pastel drawings amply attest. They have passed years of their lives in academic study, and are in every possible way a fully equipped and intellectually capable body of men. Finding themselves greatly hampered with the palette of colours fashionable in their day, they gradually reformed the same, by the exclusion of all blacks, browns, ochres, and muddy colours generally, together with abandonment of the use of bitumen, asphaltum and siccatives. The colours retained were those nearest approaching the prismatic tints, as being best capable of rendering the shimmer and palpitation of dazzling sunlight. They sought, in nature, simple compositions, and these they set down upon canvas, more by the modelling of the mass than by actual lines and spots. Values and envelopment are especially studied. Flat tints having been found insufficiently convincing, Impressionists made the great discovery (which alone renders painters for ever indebted to them) that strong light dissolves tones; that the sun's rays, reflected by objects, tend, from their very brilliancy, to dissipate the prismatic tints, and that therefore, only by juxtaposition of pure colours, could sunlight effects be adequately rendered.

When you take your next constitutional in the country, please observe and compare the effect upon your mind of some chosen piece of landscape, in the natural colouration of a gray day, and the same scene illuminated to discolouration by the sun's too ardent rays.

In the utilisation of this discovery, extraordinary results have been obtained. The distinguishing feature then, the hall-mark as it were of Impressionist painting, is the analysis and division of tones, and their application to canvas by means of dots, dabs, twirls, or lines of pure colour, juxtaposed in such a manner that they will, at a certain distance, recompose themselves in the eye and mind of the spectator, and produce a vividly strong resemblance of the particular atmospheric effect which it has been desired by the artist to convey.

A startlingly effective example of this method came under my notice a few days ago. The new Lumière colour-photography was under demonstration, a man's portrait being the object-lesson upon the screen. His collar stood out particularly bright and white —yet no white was there. Upon close examination of the screen, the effect was found to be due to the presence of some thousands of juxtaposed dots of three pure colours, viz., grass green, scarlet, and bluish violet. These three tints had combined and formed, in the eye and mind of the spectators, the effect of dazzling white, thus establishing, beyond shadow of doubt, the accuracy of that chief fundamental law of impressionist painting which has, hitherto, been most ridiculed—namely, the principle of the juxtaposition of pure tints of colour.

Modern painters acknowledge that the sun shines for them also; that he is indeed their greatest benefactor—no longer to be treated as the arch-enemy which, until quite recent years, the masters would have us believe him to be. Before the days of Turner and Constable you will search the museums in vain for any proof in the pictures therein, of consideration of light for light's sake, or of any enjoyment in the poetry of the sun. Only in Turner at his best, and, alas! one must now travel to France for much of that also, can be seen anything approaching these modern miracles of sunlight painting. Just as the pictures of these Luminists are things apart, immediately distinguishable wheresoever met with, so is the technical method of their production extraordinary. We are particularly struck by two salient features of the methods of the school. First is the simplicity of the subject-matter—the skeleton as it were upon which the effect desired to be conveyed is hung; and secondly, the number of repetitions upon separate canvasses of the same composition, or set of lines. The painting by series in fact. Yet this is by no means a new idea. It was advocated by Ruskin long years ere Manet or Monet appeared upon the scene, as may be read in the preface to the second edition of "Modern Painters"—the artists' bible.

To sum up and rebut much irresponsible criticism. An Impressionist picture worthy the title is highly finished—for that which is completed is finished. It is definite as the solution of a problem of Euclid. It is so full of knowledge that only people of cultivated taste can fully appreciate its merit. It is a cheerful optimistic picture, nobly uplifting, good and healthy to live with, a veritable antidote to the blues. So charming is it, that throughout a lifetime's association it retains its power of evoking pleasurable emotion. It never palls. One is attracted by its freedom and freshness, for at a single glance one perceives the art to be the outcome of a spirit untramelled by fetters of tradition or the theories of sciolists.

Finally, we have in Impressionist pictures an unconventional rendering of nature. We feel the vibration and palpitation of light and heat; they are fresh, radiant and sweet as a nosegay of spring flowers, and give a marvellously deceptive appearance of open air and movement, which must be seen to be believed. And what, you will naturally ask, has been the attitude of the Press and public generally in face of this glorious manifestation of a newly-created art? Alas, as usual under the circumstances, as it ever has been and probably ever will be *vis-a-vis* novelty in art—distinctly and actively antagonistic even to the point of personal violence to the innovators and of injury to the offending canvasses. This with regard to France, particularly harsh mother to strange bantlings. For instance, at one of the yearly auction sales at the Hôtel Drouot, Paris, some thirty or forty years ago, the pictures by these artists were passed round upside down, to the vast amusement of the company, and several hare-brained rascals, ready with knives to slash them, had to be expelled by the police ere business could proceed.

It required also no little courage on the part of picture dealers to risk their reputations in exposing for sale those aberrations of dis-

ordered imaginations as Impressionists' pictures were wont to be styled. In the light of recent pæons of praise and adulation such ebullitions seem almost incredible; yet that they were so, the daily and magazine press of the period only too painfully prove. How well it has been said, that "L'admiration de la foule est toujours en raison indirecte du génie individuel. Vous êtes d'autant plus admirés et compris que vous êtes plus ordinaires."

In these days of 1908, the identical pictures which in former times changed hands in the auction-room and elsewhere, at less than a five pound note apiece, are quoted and saleable at figures ranging from £300 to £3,000, and no museum of modern art can be considered completely representative which does not exhibit specimens of this style of painting. So it is with the artists themselves, most of whom are now members of the order of the Légion d'Honneur. They are highly esteemed wheresoever they may present themselves, and their works are conspicuously hung in the principal public and private galleries throughout the world.

The last barriers of official resistance to Impressionist painting in France were levelled during my student days in Paris, when in 1894 the Government accepted for the Luxembourg Gallery the Caillebotte legacy of some 40 pictures, comprising examples by all the leaders of the Impressionist movement.

The exciting incidents of that acceptance and victory for the new school will be long remembered by those who took any part in it, and its history will form interesting reading some day. The Louvre itself now houses with great honour many Impressionist pictures, and these are to be found invariably surrounded by admirers and copyists.

It may be said that we are all Impressionists now. Certainly of art students—the future directors of taste—that is a fact, for practically all those who take up landscape painting as their life's work follow with admiration the route laid out in such peril and privation by the pioneers of Impressionist painting.

For slight confirmation of this Impressionist influence regard even the work of some of our Academicians, and they of the best. At this very moment, George Clausen, La Thangue, Edward Stott, and Arnesby Brown—to name but four—are all Impressionists. The first three of these passed through the Parisian training schools a few years prior to my advent in the city of light, and right in the midst of the excitement caused by the pictures of Manet, Monet, and the rest.

Look again at our New English Art Club—sunlight painters, *par excellence*; at the old-fashioned Society of British Artists, where a strong leavening of the mass is in process; whilst the International Society naturally includes a large contingent of Impressionists, garnered from the four quarters of the globe. Almost every new art society which springs up in London, has this objective in view, as one may note in a recent issue of "The Studio," wherein all the members of the Society of Twenty-five Painters are described as Impressionists, as working distinctly on the side of the angels, as being worshippers of light, &c.

The enthusiastic critic has surely been too generous, for the gift is far too rare for it to have fallen upon so large a number as twenty-five individuals and all within the space of a year or two. However, they are all on the right track.

Abroad, practically speaking, every body of artists and every exhibition is affected: the Spaniards and Italians just now being particularly enthusiastic. American artists, being Paris trained, are Impressionists to a man. And here I feel compelled to add a word of warning to those who would study the matter further. Taste and discrimination must be used to separate the wheat from the chaff. Success naturally entrains imitators and counterfeits. There are in Paris at the present moment, some scores, possibly hundreds, of young men wasting their time upon the production of abortive paintings. These men style themselves Impressionists, and have succeeded in flooding the picture shops of the Boulevards, and the Rue St. Honoré and the Salon d'Automne, with their meaningless and offensive canvasses. They disgrace art as well as the masters whom they caricature.

France has been called the interpreter of England to the human race. It is, of course, a highly debateable point as to whether or no we can allow that astute axiom of Macaulay's its full face value. May I suggest the subject as worthy the attention of one of our many debating societies. The first impulse of those who know France best, is to deny the imputation *in toto*, and to set it down as simply another proof of insular egotism. Yet, the more one reflects upon the matter, the more one searches the files of time for proofs of confirmation or refutation, the more strongly is it borne in upon one that in writing those words Macaulay acted neither in haste nor in

malice, but with profoundest conviction of their veracity and in fearlessness of disproof.

In the domain of literature, particularly upon its philosophic side, independent and authoritative writers claim that from the days of Shakespeare right down to modern times the preponderance of original talent has lain with our country. A recent convert to this opinion appears to be Monsieur Emile Faguet, who, after noting Richardson's enormous influence, writes as follows in his instructive "Literary History of France":—

"The latest English idol of the French is John Ruskin. For ten years Ruskin has been read in France with passionate eagerness; he is translated, commented upon, paraphrased, re-arranged. It is not beyond the range of posssibility that the influence of Ruskin, in France, has created a new religion which may be called 'Kalolatrie.'"

Why this extraordinary title I cannot say. Now this brings me to the starting point of my hypothesis with regard to the very intimate connection which exists between English ideas and Impressionist painting. I desire to point out to you certain interesting and important facts of origins, which appear to have been almost entirely overlooked.

I was led to inquire deeply into all this through a simple chance remark let fall by Claude Monet in the Café Royal, London, in February, 1900. I was at the time engaged upon the preparation of a series of magazine articles upon the subject of Impressionist painting, whilst Monet was daily absorbed at the Savoy Hotel and elsewhere in the production of a remarkable series of Thames pictures. We were discussing Turner's and other British artists inadequate appreciation of the scenic and atmospheric splendours of London, when he turned to me and said, "Have you ever studied Ruskin or read George Moore." I briefly replied that I had done both, and immediately fell into a mood of reverie, linking up in my mind the connection which might or might not exist between Ruskin's writings and Monet's paintings, for up to that time I had always looked upon Ruskin as strongly antagonistic to Impressionism. Yet not so, for what do we find? Simply this, that 90 per cent. of the theory of Impressionist painting is clearly and unmistakeably embodied in one book alone of all Ruskin's voluminous output, namely, in his "Elements of Drawing." That book forms a magnificent compendium of the art of Impressionist painting, and ought to be in the hands of every student in the country, especially as it can now be possessed for the insignificant barter of one shilling. The very title with which the public has seen fit to designate the efforts of the artists composing the movement under review, derives from Ruskin. Times almost innumerable does the word "Impression" appear in that author's works. It was one of his favourite terms. We are told to "Paint our Impressions," to "Give our Impressions of the subject," &c.

As you may know, Claude Monet is popularly supposed to have originated the title, through certain Salon pictures of his having been labelled "Impressions." Ruskin, however, was using the word just about the time of Monet's birth.

Three years after the Café Royal incident, namely, in December of 1903, Robert de la Lizeranne alone, of either native or foreign critics, noticed the close affinity of Ruskinism and Impressionism in the "Revue de l'Art," wherein he styles Ruskin, the "prophet of Impressionism," giving very cogent reasons for so doing. Indeed, it is not too much to say, that had Ruskin set himself the task of illustrating Manet and Monet, as he has done Turner; or, upon the other hand, had those artists set themselves to exemplify and justify the philosopher, neither could have better succeeded. Upon the one hand, stands Ruskin's "Elements of Drawing;" upon the other, Manet's "Olympia" and Monet's "Haystacks"—the two are indissoluble complementaries.

Furthermore, had Ruskin been gifted with the ability to paint as well as he could write, to put into practice the æsthetic theories he expounded with such extraordinary clairvoyance, there is, in my mind, little doubt but that he would have ranked as the foremost of Impressionist painters. Facts all point to that conclusion. As things stand, he has relegated to Frenchmen the Turnerean mantle which might so easily have fallen to his lot.

The "Elements of Drawing," issued in 1857, may be regarded as an enlarged epitome upon the practical side of the axioms and teachings scattered throughout the various volumes of Ruskin's writings, issued from 1843 onwards. The publication of those books created a tremendous European sensation, and it is perhaps not too much to suppose that such informative and suggestive volumes would be entirely ignored by two wide-awake intellectual giants as were Edouard Manet and Claude Monet. Whether or no either "Modern Painters" or the "Elements of Drawing" existed in translated form, I cannot

say, and the point is of little consequence. English reading and speaking Frenchmen, and English artist *confrères*, have existed in Paris since time immemorial. Manet at least was a College man and Bachelor of Arts, and so would speak our language.

At the time of the publication of the "Elements of Drawing" Monet was still working under Boudin's influence, and producing pictures of harbours and shipping in and around Honfleur, which, compared to subsequent work, are black as the proverbial hat.

The sight, however, of Turner's and Constable's pictures, frequently exhibited at the Paris Salon and in London, coupled in all likelihood with the study of Ruskin's clear exposition of their underlying principle, was undoubtedly the foundation and starting point of the brilliantly successful phase of art now known to the world as Impressionism.

So that, by way of proof of Macaulay's axiom, France has once again, and this time in the field of the art of painting, become "the interpreter of England to the human race." Yet to the Ruskinian creed of Impressionism must be added a strange and exotic ingredient, for to the art of England was added a pinch of that of Japan. From Japanese colour prints and the gossamer sketches on silk and rice paper which for the past half-century have permeated French commerce, the Impressionists learnt the manner of painting scenes viewed from an altitude, with the curious perspective which results. Pissarro in particular has successfully applied this. They grasped the significance of simple subjects and fewer gradations of tonal values. By these means they found confirmation in actual practice of Ruskin's suggestions in the "Elements of Drawing" and elsewhere, for simpler lines and homelier subjects.

Pray do not suppose from what I have to say this evening, that I would wrest from the pioneers of Impressionist painting one iota of the credit and glory which is undoubtedly their due. Indeed, their position is so firmly established, that my opinions one way or another would count for little. Long years of advocacy, both by brush and pen and voice, inspired by real admiration and enjoyment of their works and profound sympathy for their sufferings, sufficiently prove my position in the matter.

The sentiment which animates me is that of one, who, knowing a good thing, takes pleasure in sharing its enjoyment among friends, coupled with the literary man's desire to probe the well-spring of an idea, and, having found it, to proclaim it from the house top in order to set at rest for ever the vexed question of origins.

We cannot, I think, go far wrong if we accept John Ruskin's dictum in matters of taste. He possessed the artistic temperament and fortified it by a life time's loving study and devotion to matters æsthetic, coupled with an inspired diction unequalled since Shakespeare's time. England may well be proud of him. In briefly tracing the extraordinary analogies which exist between Ruskin's theories, founded principally, it must be remembered, upon Turner's practice and Impressionism, I shall confine myself almost exclusively, for brevity's sake, to the great critic's wonderful book upon "The Elements of Drawing." Students will easily be able to enlarge upon this in the same author's "Modern Painters," "Stones of Venice," "The Oxford Lectures," and elsewhere.

As the matter is too technical to interest a lay audience I shall but indicate the direction of a few leading analogies; those disposed may soon hear more of it from certain magazine articles from my pen now in the Press.

Ruskin clearly perceived that:—"If any production of modern art can be shown to have the authority of nature on its side, and to be based upon eternal truths, it is all so much more in its favour, so much further proof of its power, that it is totally different from all that have been before seen."* I think you will admit, that Impressionist painting comes under that heading, certainly nothing before has been seen like it, and it distinctly has the authority of Nature on its side. Every great master of art creates his own style, which, differing from others, can neither be understood nor copied by the uninitiated. He has also to create his own audience—a still more difficult feat. Therefore, quite an education is needed, and education is a matter of time. No less than forty years have been required for public acceptance of Impressionist painting.

Five of the basic tenets of the Impressionist creed may be summarised as follows. Naturally there are many others, but time presses:—

First is the painting by the mass, which comprises simplified light and shade.

Secondly.—Coloured shadows, including notation of the purple tints in nature.

Thirdly.—Atmospheric effects and the use of opaque colour in purest tint juxtaposed.

---

* See preface to Vol. I., "Modern Painters."

Fourthly.—Composition, with its rhythm of line and roundness of touch.

Fifthly.—Tree painting, and the rendering of herbage and foliage.

Hear then what the great critic has to say regarding the first of these—the painting by the mass. It reads precisely as though, after scrutinising some picture by Manet, or Monet, he had set himself down to write, as follows :—"A good artist," says Ruskin, "habitually sees masses, not edges, and can in every case make his drawing more expressive by rapid shade than by contours ; so that all good work whatever is more or less touched with shade, and more or less interrupted in outline." The quotation is too long to give in its entirety, but its signification is great. I will not labour the point, but if what I have just read and its context does not, in a marvellously clear manner, define the artistry of Manet's "Olympia," amongst many other examples, then I am at a loss to find a better analogy, and my contention falls to the ground. Manet's exquisite piece of painting entitled "Olympia" created an extraordinary sensation at the time of its appearance, and was the *casus belli* of one of the fiercest battles of interest ever engaged upon the field of art. It was contemptuously thrown out by the Salon Jury, and came near to causing the murder of its author. Open ridicule and insult met him at every turn in the street, and in every *café* he entered, culminating in a duel with his one-time literary friend Duranty, out of which the artist emerged victorious. All this for having had the audacity to perpetrate a *chef d'œuvre* of painting. Yet the strain of the long-continued public hostility galled him to the quick, and he died prematurely on the very threshold of triumph. A brilliant soul ruthlessly sacrificed to the Juggernaut of Art.

However, taste has improved since then, and "Olympia" now hangs upon the line in the galleries of the Louvre close by several of Ingres masterpieces of painting of the female nude. Comparisons between the Manet and the Ingres forms one of the most instructive lessons in high art to be found in the whole of that superb museum. In brief, Manet completely and triumphantly eclipses his rival.

Now as to the second special quality which has been noted as distinguishing Impressionist painting : coloured shadows to wit.

Impressionists have noted sunlight's emphatic insistence upon shadow, and how that shadow is invariably coloured, despite the teaching of the careless or the colour blind, who, ignoring modern science and the research of men of genius, would still have us paint these shadows black as night and sharp as steel. Hear what Ruskin has to say upon this as far back as 1843, thus proving conclusively, even had not Turner's work exemplified it, that the theory existed long before it was put into practice by the Impressionists. It is an absolute fact, says Ruskin, that shadows are as much colour as lights are : and whoever represents them by merely the subdued or darkened tint of the light, represents them falsely. I particularly want you to observe that this is no matter of taste, but fact." There is much more writing to the same effect, but at that emphatic statement I think we can leave the matter.

Impressionists are frequently found fault with on account of their painting of violet shadows and the general purplish tint of many of their pictures. Yet, if truthful effect is to be given, that purplish tinge and those violet shadows are demanded.

Ruskin well knew this, for he says : "The quantity of purple and gray in Nature is, by the way, another somewhat surprising subject of discovery." Had the critic lived in France he would certainly have remarked this phenomenon in much greater degree there than here. I, myself, together with all the French Impressionists, have noted and painted the fact for years.

I remember distinctly during the summer of 1901 at Les Andelys on Seine, that upon two days and for two hours during the afternoons of those days, all Nature, animate and inanimate, bore the aspect of things seen under a strong glare of violet light, exactly as though a tinted glass were suspended between the sun's rays and the earth. The effect was most curious and disturbing. Nature appeared to be toneless and flat. High lights and shadows were attenuated almost to extinction, whilst in this dull purple glare the heat became more intense than ever, possibly through lack of wind, for all was still.

With regard to the third distinguishing quality of Impressionist painting—*colour* ; pure brilliant harmonious colouration. Here again the analogy between Ruskin's teaching and the Impressionist practice is absolutely amazing. "You may," says Ruskin, "in the time which other vocations leave at your disposal produce finished, beautiful, and masterly drawings in light and shade. But to colour well requires your life. It cannot be done

cheaper. Nothing but the devotion of a life and great genius besides can make a colourist. If you sing at all you must sing sweetly, and if you colour at all you must colour rightly. Noble men learned their lesson nobly. The base men necessarily learn it basely. The great men rise from colour to sunlight. The base ones fall from colour to candlelight. So, it would appear from the foregoing that the greatest art of the greatest colourists must be applied to sunlight painting. I contend that Manet, Monet, Sisley, La Thangue, George Clausen, Emile Claus, Segantini, Sorolla-y-Bastida, and others have risen to the occasion, and have succeeded in imprisoning in paint many beautifully convincing manifestations of sunlight effect.

Now, however, comes a paragraph which completely epitomises one of the most characteristic features of Impressionist painting: that of the juxtaposition of pure tints of colour. Ruskin wrote it long before the appearance of Impressionist pictures as we now know them. The Pre-Raphaelites alone of all the artists in the world, were at the time partially applying the system, as follows :—In distant effects of rich subject, wood, or rippled water, or broken clouds, much may be done by touches or crumbling dashes of rather dry colour, with other colours afterwards put cunningly into the interstices. The more you practise this, when the subject evidently calls for it, the more your eye will enjoy the higher qualities of colour. The process is, in fact, the carrying out of the principle of separate colours to the almost possible refinement ; using atoms of colour in juxtaposition, instead of large spaces."

For striking examples of results to be attained by this method, see Monet's "Haystacks in Sunlight," and note the darkened edges of the hay where the highest light pours around it, and note also the quality of paint by which that light is arrived at, and particularly study the shadows of those stacks. I guarantee that all this will come as a revelation to most people, even to professional artists. Never more have Ruskin's theories been more convincingly put into practice ; or, upon the other hand, Monet's practice better indicated. As prophetically indicated as it is now startlingly indicated by Lumière's scientific demonstrations in colour photography.

I am compelled to cease my analogies here, but the student who will trouble to dig into the "Elements of Drawing," will discover how in the matter of composition, of touch, of Tree drawing, and the rendering of Sea and Sky, Ruskin's theories form the very foundation of Impressionist painting, and no better origin can be desired.

Philosophers and gifted writers have summed up for us the burthen of the debt which posterity owes to each Impressionist in particular, and to Impressionism generally. To the first, rare examples of the most sterling qualities of character, apart from art ; to the second, the legacy of some hundreds of exquisite creations, absolutely new in style, epoch-making, and models for the admiration and emulation of generations to come.

As to the trend of the future development of the art, time alone can show. Many brilliant intellects throughout the world are daily solving that problem. Yet it will be palpable, even to the dullest observer, that an art which is so eloquently and truthfully preaching the gospel of Light, that strives to bring into our homes and drab sad lives, some suggestions and glimpses of blessed sunshine will and should flourish abundantly. Above all, foggy, dyspeptic England would profit by its cult, and would be the healthier and the happier were all its inhabitants Impressionists — in spirit at least—taking joy in the sight and possession of radiant colour and a purer atmosphere, in which that colour alone is possible. And who of more right than we to the enjoyment of these bright treasures of painting, since the art which has rendered them possible owes its very existence to the need of our country and the genius of our race. Very justly has Ruskin observed that :—"Wherever people are noble they love bright colour, and wherever they can live healthily bright colour is given them in sky, sea, flowers, and living creatures."

DISCUSSION.

The CHAIRMAN (the Earl of Plymouth), in opening the discussion, thought one clear lesson to be drawn from the paper was that people should not criticise hurriedly and adversely things which they did not understand. There was no blame attaching to an art critic or anyone else for not understanding a mode of expression that might be entirely new to him ; and therefore he thought they should avoid doing that great injustice which the author reminded them was done to the French pioneers of Impressionism, not only by neglect of their work but by the violent hostility to it which sometimes drove them almost to their graves. He did not know that in these modern days silence would not be considered almost worse than violent attack.

He thought people would rather prefer to raise a hot controversy and to have their work violently criticised than that it should be entirely ignored. But at any rate one could not be right in attacking those who were doing earnest work simply because it was novel, and that, he thought, was a lesson which should be learnt from the history of Impressionism. In the next place, he thought they should be catholic in their tastes. The more varieties of artistic expression one took the trouble to look into, and, so far as one was able, to master to a certain extent, the wider were the possibilities of enjoyment; and, therefore, he thought, they should approach anything new with the earnest desire to become so well acquainted with it that they were able to appreciate what was the best and the worst in it. No one should imagine that Impressionism was a short cut or an easy road to fine artistic work. It was perfectly clear from what the author had said, that the problem which the Impressionists set themselves to solve was one of the most difficult, perhaps the most difficult, that artists could find, namely, the interpretation of full sunlight. That was not attempted for the best part of two centuries. It was a problem that Impressionists had undoubtedly gone nearer to solving than any other body of artists had done before, and it had only been arrived at by many years of serious study. It seemed to him that the essential truths which they had given in their pictures, were those arrived at after the most deliberate selection, after the less important ones had been carefully put on one side, and eliminated. So that if anyone imagined that he could easily jump to that conclusion by any careless selection and work, he was only, he thought, making failure for himself certain, and it was a failure gigantic in proportion to the height to which he aspired. One other point which came to his mind was that an artist's manner should not readily be copied. That was certain to degenerate into mannerism; and, after all, the object of every artist, if he had anything really worth saying, should be to say what he had to say in the most natural, the most spontaneous, and the most individual manner he possibly could. He preferred the name suggested by the author of Luminist rather than Impressionist, because the painting of sunlight was really the main object, and because an impression, as a pure impression, apart from that painting of sunlight, might be equally obtained by those who sought for tonal effects and used palette mixed tints. An impression could be equally given by those means, but it was one in a totally different key, and did not attempt to give the brilliance of full sunlight which those who were now called the Impressionists had set themselves to produce.

Mr. J. D. CRACE said he disputed Mr. Dewhurst's right to claim Turner as an Impressionist. That Turner opened the way to what the French called Impressionism was no doubt true, but before any pictures were painted by Turner which could in any sense be claimed as an illustration of Impressionism, he had graduated through the media of the ordinary form of study. But he had gone much further than that; he had painted those marvellous effective representations of Nature which even to this day remained by far the most valuable works of his career. Perhaps the middle and later periods of Turner's painting would be recognised as the most delightful and full of atmosphere. They were even beyond those masterly works which followed later, which were not put forward as impressions but as imaginations. Turner's paintings of the class which would come under the Impressionist type of execution were not put forward as impressions; they were compositions and poetical imaginations. Nobody could suggest that Constable painted pictures by dots of pure colour. Far from it. They were painted in very subdued tones of colour. If the Impressionists claimed that they were the first who had approached the painting of the sunlight and the beauties of the atmosphere, what became of the wonderful skies of Cuyp and the landscape paintings of Hobbema, works which excited the same admiration to-day as they did 200 years ago? It seemed to him that no painting should ever try to assume that it was a trick. It had been ascertained scientifically that the whole range of colour in the form of pigments was limited to something like 100 degrees, *i.e.*, working upwards, a scale could be obtained, divisible roughly into 100, as compared with the scale of nature of about 20,000. If a sheet of white paper was placed in the shade, and a similar sheet was placed in the sunlight, the difference was counted by thousands. Therefore, no painter could paint what he saw, strictly speaking; he must paint with a lower tone in order to convey the impression of the amount of gradation that took place in Nature. It could only be a compromise. He was unwilling to criticise the paintings of the author which were exhibited, but in some of the works the purity of colour in the two planes practically diminished the comparative distance. The atmospheric perspective was to a certain extent sacrificed; and taking the pictures altogether he should say that the one which was least to be identified with the ticket of Impressionism came nearest to what he should say was the aspect of Nature as ordinarily seen. In speaking of the question of shadows, Ruskin very properly laid down for students in his little book on Elementary Drawing that shadow should never be a mere darkening of the local colour. No painter of any repute ever did paint shadows as merely a darker shade of the local colour. Painters ever since they had painted in perspective had quite understood that the shadows were full of reflected light, and took the tone of the different colourings that existed. There was a little picture by Gérome exhibited last year in the Guildhall of an interior with very imperfect light and apparent gloom, which, when it was looked into, was a mass of colour. The only objects in light were a few cocks and hens, but the picture as a whole was full

of beautiful colour although it portrayed gloom. The great Italian painters never thought of painting a shadow in simply a dark tone; in fact, there was no doubt that the brightest tone was not found in sunlight, but in the half lights. Dealing with the question of the effect of distance, atmosphere, and light as incompatible with the tone, there was another picture by Dyce in the same exhibition which he remembered being exhibited in the Academy a great many years ago, of George Herbert walking by the riverside, with a tree in the immediate foreground, with the river and the distant landscape which was full of atmospheric beauty and painted like a miniature. It was not by tricks and method that any artist rose to the first rank. Art was art. He quite agreed there were many works of Impressionists which were exceedingly beautiful, but there was also an enormous number of works which had brought them into ridicule. Going back to Turner, that eminent painter walked through art to his more vivid pictures without exciting any of the opposition that occurred with the Paris Impressionist school; he developed his perception of colour by actual learning and study, but a great many of the Impressionists jumped into the new method, as it were, as an escape from having to study. In certain effects of the atmosphere one saw the bluish purple tones of shadow, of which some of the Impressionists were fond; but that characteristic of shadow was a characteristic of certain lights only, and did not apply to everything and every scale. Many of the pictures painted under the title of Impressionism seemed to think that a blue-purple shadow was indispensable to convey the idea of shadow. As a matter of fact it belonged to a particular light, a particular time of day, and a particular condition of weather and atmosphere. There were great painters who understood all the marvels of atmospheric effect before the last century; and although he agreed that French landscape painting was at a very poor ebb when it broke tradition, he thought it was a mistake of one particular school to set up the idea that it had found out what Nature meant. He thought men like Turner, Bonington, and Constable interpreted Nature with wonderful vigour and beauty without ever having approached the methods which the author had put forward so ably in his paper. People were too much given to attaching value to the mannerism or the method of painting, and did not sufficiently observe that many schools at many times had arrived at wonderful interpretations without adopting that particular method.

Mr. DEWHURST, in reply to Mr. Crace's remarks, said he hoped he had made clear in his paper that he was not a one-sided critic. He knew that beautiful conventions of art existed outside Impressionism, and he had stated that the list of Impressionist painters did not cover the names of all the great emotional artists. He quite agreed that the pictures of Turner of his middle and latest period were the best, and that they were beautiful, imaginative outpourings of a highly poetical mind. Turner did not call his works impressions, neither did the Impressionists call their pictures impressions. The man in the street had dubbed them that. The word "impression" as it was now used conveyed to the general public a very wrong idea of their ideals of art. For instance, Whistler was known as an Impressionist because he subordinated details and jumped quickly to an effect, no matter the technique by which he obtained it. Therefore he had become known as an Impressionist, and passed in Paris as such, although he was not received there and on the Continent as an Impressionist; in fact, he was not an Impressionist. As the Chairman very aptly put it, Impressionist painting was that kind of painting which went for qualities of light and atmosphere, which were only to be obtained in their highest degrees of manifestation by those practices used by Impressionists, and the juxtaposition of more or less pure tints of colour. The remarks Mr. Crace had made, with regard to gradation, were perfectly true. All art was, more or less, give and take; it was impossible to have everything in a picture. The Impressionists had given up the scale of darkness; they did not go to the full extent of the depths. On the other hand, they had certainly arrived at a great deal higher gradation of light, in his honest conviction, than had ever hitherto been obtained, either by Turner or anybody else. The skies of Hobbema and Cuyp were very beautiful, but they had not been arrived at by the mode of painting which the Impressionist would use. They were very beautiful, however, for all that. On the question of shadows, he preferred to leave what Ruskin said on that subject just as he wrote it. After 25 years study of Ruskin, the more he knew of the man and his works the greater he admired him. He was an enormous intellect, and had a wider influence upon modern art than had hitherto been suspected. It was perfectly true that the richest colours were not to be obtained by sunlight, as Mr. Crace said. He had stated in his paper that vivid, intense sunlight dissipated tone, and brought down the colour value of a scene from Nature. At the same time, in extremely high lights the shadows in sunlight naturally sent up the scale enormously. The most beautiful and natural colouring, as every student knew, was that of the grey day, and as there were many of those in this country some of the most beautiful colouration was to be found here. But it was not sunlight, and the impressionist painters attempted, successfully he held, to paint something that had not been done before. He hoped he had successfully proved that they had done a new thing, and done it beautifully.

Mr. J. PENNELL said that if he had had time to go into the whole question he could have refuted almost every word the author had said. The statement had been made that in the early days impres-

sionists were absolutely ignored. As a matter of fact they were ignored by the official artists only. On their pictures being refused at the Salon, they held a show at Boudin's Studio, which demonstrated their position, and in the following Salon the scandal of the second rejection of their pictures produced such an effect that Napoleon III. caused them to be exhibited in a special exhibition which made their reputation. He disagreed entirely with the author's statement with regard to Ruskin. The reason that Ruskin praised what he called Impressionism was simply due to the fact that from the time that men painted themselves blue they had all been impressionists. Ruskin could be read in any kind of spirit, and any particular individual could get out of Ruskin exactly what he desired. He contended that when Ruskin talked about the division of colour and pure colour he was referring to the earlier Italians, and if the author would go to the National Gallery and see the pictures exhibited there, he would see the work of the men of whom Ruskin was speaking, who knew more about true colour than anybody else at the time—Piero della Francesca. Exactly the same thing would be found, not only in Francesca, but in Guardi, Rembrandt, Velasquez, and all the painters right through the centuries, and if the author wished to know the origin of Impressionist handling, he should study the frescoes of Ravenna. He disagreed altogether with the remarks the author had made about Manet's pictures, many of which were not painted in the way described at all. What Impressionism really meant was looking at a thing for oneself. Fortuny painted light in a way that the Impressionists had never attempted, and he defied the author to find any Impressionism in some of the pictures that were called Impressionist. Impressionism did not at all mean the painting of light, but it meant the painting of anything in a personal fashion. Full sunlight had nothing more to do with Impressionism, than Lumière's photographs had to do with fine art.

Mr. DEWHURST, in reply, said it was difficult to take Mr. Pennell seriously, but he did not believe for a moment that Francesca had anything to do with the matter at all. When Ruskin was writing his "Elements of Drawing" and "Modern Painters" he had one artist in view, and one only, namely, Turner. He demonstrated that Turner was the greatest artist that had ever lived, that he had discovered technicalities which were not before in existence, which Ruskin made himself master of in order that he might give forth to the British public and the world at large the enormous genius that was to be found in Turner's paintings.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to the author for his interesting paper, and the meeting terminated.

HOME INDUSTRIES.

Miners and their Hours of Labour.—Attention was recently directed in these Notes to certain considerations which induce many representative business men to view with grave misgiving the Coal Miners (Eight Hours) Bill, 1908, now before Parliament. Since then the Home Secretary has received two deputations who put before him what they conceived to be weighty objections to the measure, whilst well-known representatives of some of the great industries of the country have published a statement in which they express their conviction that to limit the hours of labour to eight from bank to bank would be to throw a largely increased burden on all the great industries in the country which depend for their existence and prosperity on coal. Nor can it be forgotten that the Home Office Committee, though suggesting some mitigating considerations, were convinced "that the establishment of a fiscal eight hours day, whether introduced suddenly, or gradually by annual reductions of half an hour, cannot but result in a temporary contraction of output and a consequent period of embarrassment and loss to the country at large." As was pointed out in this column, the miners are not united in their demand for the change. Both the Durham and the Forest of Dean miners are opposed to it, and it is evident from the Home Secretary's replies to the deputations, and his answers to questions in the House of Commons, that he is himself apprehensive. He considers that the contraction of hours has become inevitable, because opinion in favour of the measure has become too strong to be longer resisted, but he warns Parliament that it may have a serious effect upon many home industries, whilst if the coal owners are right there will be a reduction of output of about 26 million tons per annum, and a consequent rise of price to the consumer of 2s. per ton at the lowest.

Coal and other Home Industries.—It may be that should the Coal Mines Bill become law experience will prove that the fears now so authoritatively expressed will prove to be groundless, and that the improvement of methods, and the improved machinery, will prevent any reduction of output, and any increase in the cost of coal. However that may be, the wide reaching effect of the rise of a shilling or two per ton in the price of coal is not disputable. For shipowners it would be a most serious matter, since the coal bill constitutes practically one-half the expense of operating a modern cargo steamer, and a 2s. per ton rise in the price of coal would mean an increase of from 15 to 20 per cent. in the cost of operating tramps. Moreover, our coal exports would decline to some extent, which must be unfavourable to the shipping industry, since there is no other bulk cargo wherewith to replace coal at our ports. Nor would a rise in the price of coal be less serious for the iron trade. It was given in evidence before Mr. Burrell Rae's committee that the quantity of coal consumed in our iron and steel industries is not less

than 31,000,000 tons per annum, and Mr. J. S. Jeans stated that the addition of 6d. per ton to the price of coal means an increase of £780,000 per annum in working expenses of the iron industry. If this calculation may be accepted as correct, and an eight hours law raised the price of coal 2s. per ton, it would mean the addition of £3,120,000 per annum to the cost of production in our iron industries.

Capital in Breweries.—Many causes have been at work to depreciate the value of brewery holdings—dear money, increased competition, multiplication of other securities, the dread of legislation—and whatever the relative effect of these causes, the loss to investors has been very great. The writer has before him a list of 36 brewery debentures of the first-class, representing as a rule the initial charges on the respective properties. The decline ranges from 5 per cent. to 25½ per cent., a depreciation representing in money value £3,425,000, or 14·1 per cent. in the best class of brewery properties. In the less well secured classes of brewery values the fall has naturally been much more severe. An interesting light upon the classes of the community who are the chief sufferers is shown by a circular issued last week by a well-known brewery company, from which it appears that 35 per cent. of the debenture stocks and preference capital of that company is held by the professional classes, and 43 per cent. by trustees under wills and by women. In recent years charges over which brewery directors have no control have grown rapidly and largely. The extra taxes on beer and spirits imposed in 1900 for the purposes of the war remain, and some £22,000,000 has already been hereby drawn from the trade since 1899 over and above the pre-existing taxation. Comparing 1889-90 to 1901-2, there has been, as regards the average ratepayer, an increase of 35 per cent. in the rate levied, and of 10 per cent. on the value assessed; but the increase in payment of rates as regards licensed property shows considerably more than double that increase, and to this must be added consequential burdens. The publican's license is affected by the amount of his assessment, and for the twelve years ended 1901-2 the amount of duty increased 20 per cent. Again, since 1904 the trade has been liable to the annual levy of the charges that form the fund out of which compensation for licenses withdrawn as redundant is paid. These charges have meant in the three years 1905-7 a payment of £3,289,163, which represents a loss of dividend of from 1½ to 2½ per cent. on ordinary shares.

The Storage of Motor Spirit.—Although the trade in petroleum spirit for explosive motors only came into existence with the present century, the United Kingdom already imports some 120,000 tons annually, and the imports of motor spirit last year would have been even larger than those recorded, if there had not been a scarcity of suitable tank steamers. But the storage arrangements on the Thames remain very inconvenient. In the engineering supplement of *The Times* (March 11) Mr. J. D. Henry explains them. Bulk petrol-carrying vessels, partly or wholly loaded, are not allowed to proceed further up the Thames than Thames Haven, where they must discharge either into the tanks ashore, or into licensed barges, which are not prevented by the regulations of the Conservancy Board from taking their cargoes to any point on the river either up or down. At Purfleet, which is a little higher up the river, although the chief importing company has two specially constructed storage tanks, duly licensed and worked in accordance with the local bye-laws, the Conservancy Board will not allow importers to unload barges or steamers at this point. The result is that the spirit has to be landed at Thames Haven, pumped into tank cars, and taken by rail from Thames Haven to Purfleet, where it is reloaded, put on the rail again, and taken to Silvertown, the point to which large quantities of petrol are pumped into small coasting steamers and barges. Although the Conservancy Board prohibit the discharge of spirit at Purfleet there is no regulation against the landing and storage or loading of spirit at this point, neither is there any interference with the petroleum spirit trade at Silvertown, and there is nothing to prevent a company from sending petrol laden barges up to Westminster Bridge.

The Growth of Insurance.—The rapid development in all branches of life assurance in the United Kingdom during the last twenty years is shown by the returns furnished annually to the Board of Trade by British companies. These have just been issued and show that the premiums on ordinary insurances have increased from £13,033,945 in 1888 to £25,332,893 in 1907; and industrial insurances, taking the same period, from £5,523,811 to no less than £31,765,237. The total assurances in force at the close of last year amounted to £713,491,783 under ordinary tables in addition to £251,553,949 by means of industrial policies.

CORRESPONDENCE.

MEXICAN RUBBER.

The enormous increase in the value of rubber exported from Mexico does not seem to have attracted much attention in this country up to the present, but the following figures which I have extracted from the Official Returns compiled by the Mexican Government appear very striking:—

Fiscal year.	Exports. dols.
1902–3	325,012
1903-4	520,767
1904-5	719,104
1905–6	2,390,425
1906–7	6,678,926

The increase appears to continue up to the latest available figures as the comparison for the following months will show:—

	1906. dols.		1907. dols.
July	215,483	..	640,936
August	294,989	..	705,285
September	380,445	..	657,599
October	318,524	..	759,298
November	464,788	..	721,660

It may be interesting to note that the exports for the financial year, 1906–7, were taken by the following countries as under:—

	dols.
Belgium	15,217
British Honduras	52
France	78,593
Germany	649,831
Great Britain	2,570
Italy	384
Spain	21,868
United States of America	5,910,411
	6,678,926

The foregoing figures confirm information I had received from other sources to the effect that considerable interest is being taken in rubber planting in Mexico by their neighbours in the northern part of the American Continent, and there would seem to be a good field open for English enterprises in the same direction.

It is much to be regretted that some few years ago money was lost in connection with a highly speculative undertaking that was presented in this market, but an experience of this kind should not deter *bonâ-fide* investors from looking into what would appear to be an opening for sound commercial business.

S. Chapman.

225-8, Gresham-house, Old Broad-street,
London, E.C.,
March 5th, 1908.

DESIGN TEACHING.

May I be allowed to reply to the question raised in the number of the *Journal* for March 13th (p. 449), on "Design Teaching in Girls' Secondary Schools?" It is argued "that it seems rather a pity that the people who do well in the design year should not carry that kind of work further next year, instead of taking up something quite different."

It must be remembered that the subject of drawing should be taught educationally, that the pupils on leaving may have their minds and eyes open to learn and see more. My experience leads me to prefer to give a year's course of design, elementary, but, I trust, not superficial, to girls of 15 or 16, many of whom will be leaving at the end of that year: a slight training in appreciation of what is fitting and good in objects of daily use. Those who do well in the subject find out that they need more careful observation and more strict drawing before their design can progress much farther. For the rest of the class, in collective teaching,—while the average Briton, from an early age, is still inclined to pass sweeping adverse criticisms upon matters of art without any knowledge of the subject,—it is most valuable educationally to appreciate the subtleties of colour and form. The latter is correlated with the classical and European history. The pupils more apt at design are then fitted to learn it technically with better equipped minds at an art school, or under a teacher who may be qualified to teach the subject as a speciality, just as others are sent forth to enter on a university curriculum.

Ethel M. Spiller
(Art Mistress Dulwich High School, and
Hon. Sec. International Art Congress).
11, Highbury-crescent, N.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

March 25.—"Recent Improvements in Decorators' Materials." By A. S. Jennings. Sir William Emerson, Past President R.I.B.A., will preside.

April 1.—"Dr. Schlick's Gyroscopic Apparatus for Preventing Ships from Rolling." By M. Wurl. Sir William Henry White, K.C.B., F.R.S., will preside.

April 8.—"Technical Education in America." By Sir William H. Preece, K.C.B., F.R.S. Charles Moberly Bell will preside.

April 29.—"Modern Roumania." By Alfred Stead, Consul-General for Roumania. Sir Percy Sanderson, K.C.M.G., will preside.

May 6.—"The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds." By Lovell N. Reddie.

May 13.—

May 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. Martin Duncan.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

April 30.—"Reminiscences of Indian Life." By the Right Hon. Lord Lamington, G.C.M.G., G.C.I.E., late Governor of Bombay.

May 21.—"The United Provinces of Agra and Oudh." By Sir James John Digges La Touche, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

March 24.—"The Mineral Resources of Western Australia." By the Hon. C. H. Rason, Agent-General for Western Australia. Admiral Sir Frederick G. D. Bedford, G.C.B., Governor of Western Australia, will preside.

April 7.—"The Imperial Problem of Asiatic Immigration." By Richard Jebb.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

March 31.—"Enamel Portraits." By Cyril Davenport, F.S.A. Sir Hubert von Herkomer, C.V.O., R.A., will preside.

April 28.—"Lace as a Modern Industry." By Miss Isemonger. Alan S. Cole, C.B., will preside.

May 26.—

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Professor Vivian B. Lewes, "Fuel and its Future." Four Lectures.

Lecture III.—March 23.—The smoke problem —Bituminous coal unfitted for any fuel purpose— —Smokeless fuels—The question of high *versus* low temperature carbonisation in the manufacture of illuminating gas—The gas industry and its work in the future.

Lecture IV.—March 30.—The internal combustion engine *versus* steam—Gaseous fuel and power production—The utilisation of peat—The regeneration of Sun energy when our present fuel supplies are exhausted—Alcohol as a fuel, and its possibilities.

William Burton, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.

May 4, 11, 18.

Shaw Lectures on Industrial Hygiene.

Tuesday and Friday evenings, at 8 o'clock :—

May 15 (Friday).—"The Dangers of Coal Dust, and their Prevention." By W. E. Garforth, President of the Colliery Proprietors' Association of Great Britain.

Howard Lectures.

Thursday evenings, at 8 o'clock :—

H. S. Hele-Shaw, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

Lecture II.—March 26.—Navigable aerial contrivances in which the force of gravitation is opposed by means of floatation, *i.e.*, dirigible balloons—General theory—The balloon as a structure —Structural design of the framework—The form, construction, and pressure regulation of the containing envelope—Horizontal and vertical steering—A comparison of the balloons, Meusnier, Dupuy de Lome, Renard and Krebs, Gifard, Wolfert, Santos Dumont, Zeppelin, Lebaudy, Parseval, Barton, De la Vaulx, Nulli Secundus.

Lecture III.—April 2.—Contrivances in which the force of gravity is opposed dynamically—The methods adopted in nature—Birds, flying reptiles, flying animals, and flying fish—The stability and resistance of an aeroplane—Kites, parachutes, and the gliders of Lilienthal, Pilcher, Chanute, and the Wright Brothers—Lessons to be learnt from the use of models—Comparative features of the flying machines of Santos Dumont, Delagrange, Bleriot, and Farman, and others.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 23...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Vivian B. Lewes, "Fuel and its Future." (Lecture III.)

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, March 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) The Hon. C. H. Rason, "The Mineral Resources of Western Australia."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. A. Wallis Budge, "The Egyptian Sudan : its History, Monuments, and Peoples—Past and Present." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. Robert Richard Gales, "The Curzon Bridge, at Allahabad." 2. Mr. Archibald Scott Napier, "The Netravati Bridge, at Mangalore."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4½ p.m. Mr. E. R. Davson, "British Guiana and its Development."

Faraday Society in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W., 8 p.m. Presidential Address by Sir Oliver Lodge, "Some Aspects of the Work of Lord Kelvin."

Wednesday, March 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. S. Jennings, "Recent Improvements in Decorators' Materials."

United Service Institution, Whitehall, S.W., 3 p.m. Sir R. Giffen, "The Necessity of a War Chest in this Country, or a greatly increased Gold Reserve."

Royal Society of Literature, 20, Hanover-square, W., 8½ p.m.

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

Thursday, March 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lecture.) Professor H. S. Hele-Shaw, "The Navigation of the Air." (Lecture II.)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 5 p.m. (Annual Meeting.)

Royal Institution, Albemarle-street, W., 3 p.m. Dr. R. T. Glazebrook, "Standardisation in Various Aspects. 2. Electrical Engineering."

Friday, March 27...Royal Institution, Albemarle-street, W., 9 p.m. The Hon. Robert John Strutt, "Radio-Active Change in the Earth."

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Physical, Northampton Institute, Clerkenwell, E.C., 5 p.m. Dr. C. V. Drysdale :—1. "Notes on the Plug Permeameter." 2. "The Use of Shunts and Transformers with Alternate Current Measuring Instruments." 3. "Wattmeters."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. 1. Dr. F. J. Brislee, "Combustion Processes in English Locomotive Fire-Boxes." 2. Mr. Lawford H. Fry, "Combustion Processes in American Locomotive Fire-Boxes."

Saturday, March 28...Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. J. Thomson, "Electrical Discharges through Gases." (Lecture IV.)

Journal of the Royal Society of Arts

No. 2,888. VOL. LVI.

FRIDAY, MARCH 27, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 30, 8 p.m. (Cantor Lecture.) PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." (Lecture IV.)

TUESDAY, MARCH 31, 8 p.m. (Applied Art Section.) CYRIL DAVENPORT, F.S.A., "Enamel Portraits."

WEDNESDAY, APRIL 1, 8 p.m. (Ordinary Meeting.) M. WURL, "Dr. Schlick's Gyroscopic Apparatus for Preventing Ships from Rolling."

THURSDAY, APRIL 2, 8 p.m. (Howard Lecture.) PROF. H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." (Lecture III.)

Further details of the Society's meetings will be found at the end of this number.

FOTHERGILL PRIZE FOR LIFE-SAVING APPARATUS.

The Council of the Royal Society of Arts are prepared to award, under the Fothergill Trust, a Gold Medal, or a prize of £20, for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious.

It is intended that the apparatus sent in shall be submitted to practical trials and tests.

In the award of the Medal regard will be had, firstly, to excellence of design and contrivance, and, secondly, to excellence of manufacture. Credit will be given to such parts of the apparatus as are the invention of the exhibitor; the object being to distinguish the apparatus which gives the best promise of being practically useful.

Inventors intending to compete should send in a notice of their intention, together with a full description of their inventions, *not later than 31st March*, 1908, to the Secretary of the Royal Society of Arts, John-street, Adelphi, London, W.C., and in cases in which the apparatus has been put into actual use, the experience of such use should be given, and the special points of merit of the apparatus indicated.

Notice of the place to which the apparatus is to be sent will be subsequently sent to those competitors whose apparatus the judges may desire to test, together with an indication of the tests, and of the manner in which they will be conducted.

Competitors intending to patent their inventions should be careful to obtain protection, as the Council of the Society cannot undertake any responsibility as regards the secrecy of the whole, or of any part, of an invention submitted to them.

The Prize will be awarded on the report of judges appointed by the Council.

The competition is not limited to British subjects.

The Council reserve to themselves the right of withholding the Prize, of extending the time for sending in, or of awarding a smaller Prize or smaller Prizes.

CANTOR LECTURES.

On Monday evening, 23rd inst., PROFESSOR VIVIAN B. LEWES delivered the third lecture of his course on "Fuel and its Future."

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, March 24; H. E. ADMIRAL SIR FREDERICK G. D. BEDFORD, G.C.B., in the chair.

The paper read was "The Mineral Resources of Western Australia," By the HON. C. H. RASON.

The paper and discussion will be published in a future number of the *Journal*.

HOWARD LECTURES.

On Thursday evening, 26th inst., Dr. H. S. Hele-Shaw, F.R.S., delivered the second lecture of his course on "The Navigation of the Air."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

SHAW LECTURES ON INDUSTRIAL HYGIENE—III.

THE HYGIENE OF THE POTTERY TRADE.

By William Burton, F.C.S.

Delivered on Friday evening, Feb. 7th, 1908.

Considering all that has been said against the pottery trade during the last ten years by more or less irresponsible outsiders, I have the feeling that I ought to stand before you in a penitential sheet. That, however, is not my attitude. I come here instead to explain what difficulties and dangers there are in connection with the manufacture of pottery, to admit them freely where they exist, and at the same time to endeavour to show that they are all, happily, in process of extinction. Whether the extinction will be rapid or slow depends on circumstances for which the manufacturer himself is not entirely responsible.

It would be easy to demonstrate, when we remember the numbers of workpeople employed and take into consideration the amount of mischief caused to the workers in the pottery trade, that the whole industry is less inimical to those who work in it than many other dangerous trades; but two blacks do not make a white, and while I could readily indicate trades which are in greater need of attention than the pottery trade is now, my sole business to-night is to consider the present position of our trade in its influence on the health of the workers.

Leaving aside for the moment questions of excessive or irregular temperatures, insufficient ventilation, &c., which are of minor importance, it is certain that the chief danger to the health of pottery operatives can be summed up in the word "Dust." The trade is one of many processes—probably no more detailed and intricate manufacture exists to-day—and in many of the processes dust is naturally and necessarily created. Two kinds of dust always arising in pottery works must be considered.

(*a.*) The mixed mineral dust, composed of particles of finely ground clay, flint, felspar, or stone, which is created in the shaping and finishing of the clay vessels (plates, cups, dishes, &c.) before they are fired, or in suitably arranging them in saggers or fire-clay boxes for firing, or in preparing them for glazing and decorating after they have been once fired.

(*b.*) The dust of glazes containing lead compounds, smaller in amount than the other, affecting a much smaller number of workers, but far more dangerous to health on account of its toxic properties.

The course of my lecture is definitely laid out for me by this simple subdivision of the main problems that concern the health of pottery workers. I want to make it plain, from the outset, that the great danger is the creation of dust—the dust of potters' clay, of fine flint or stone, on the one hand, or the dust of glazes containing toxic ingredients on the other.

Roughly speaking, some 73,000 workpeople are employed in Great Britain in all the processes connected with the making, decorating, and finishing of pottery. Of these not more than 26,000 are exposed to danger from any kind of dust. The remainder are employed in callings which are not only, generally speaking, less laborious and less dangerous than any other trade, but in callings that are as free from risk as, say, that of an ordinary clerk in a merchant's office. In one sense, therefore, it is unfair to speak of pottery as a dangerous trade; it is a trade divided into many branches, each of them presenting a great variety of separate occupations, some of which are undoubtedly inimical to health unless they are conducted with due regard to their special dangers.

Reverting to our division of the various kinds of dusts into mineral dust and toxic dust, we can further subdivide these 26,000 workers into two groups:—(1) Some 19,000 workers who are exposed to the risk of breathing the mineral dust of powdered flint or potters' clay; and (2) 6,500 to 6,700 workers who are exposed to the risk of breathing dust containing lead compounds. It is upon these two groups of workers that our attention must be concentrated.

One further complication needs a word of explanation. Pottery is a very wide term used to cover everything manufactured of clay—paving and decorative tiles, sanitary ware, stoneware, earthenware, brown tea-pots, and

china. In the majority of works only one branch of manufacture is followed, but there are a number of large and important works in this country where many kinds of pottery are made. It cannot be too clearly borne in mind that each of these branches of manufacture differs in important particulars from the other, and that rules and regulations possible in one may be quite impossible in another, owing to the difference of working conditions. The figures quoted already as to the number of workpeople employed and those exposed to any special trade risk relate to the whole industry.

Fig. 1.

"Towing" of Earthenware.

We must now consider the effect on the workers of employment in processes where mineral dust is produced. I am not a medical man, of course, so that I shall not attempt to treat this question from the medical point of view. The general consensus of medical opinion—though there seem to be some weighty authorities who do not accept the general view—is that when clay dust, flint dust, or any similar mineral dust is regularly breathed during a portion of the working day, such condition of employment gradually produces considerable and serious mischief in the lungs. Among potters, this lung condition has in the past been generally spoken of as "potter's asthma" or "potter's phthisis." It seems to be clearly established that it is neither one nor the other. The dust causes a degradation or a breaking down of the delicate lung tissues, but, provided a worker so affected is able to keep clear of the infection of "phthisis," and he is not attacked with other lung diseases, he can go on working to old age, and die at last from what are apparently natural causes. But the degraded condition of lung produced by the regular breathing of fine mineral dust naturally pre-disposes that workman to other forms of lung disease; and our greatest difficulty in dealing with this trade disease is the fact that the case is nearly always complicated by organic disease changes over which the manufacturer has no control, and for which it seems, therefore, unfair to hold him responsible. You may very well ask the question at this point, if the facts are as I have stated, why does not the manufacturer conduct his process in such a way as to avoid the production of dust?

I must say at once that it is impossible to make and finish pottery without producing dust in certain operations, and all hope of reform or improvement of past conditions lies in the invention and adoption of suitable appliances and arrangements for dealing with the dust so

that it shall not be breathed. It would be impossible, in the time at our disposal, to consider all the dusty processes in detail. I propose, therefore, to select two or three of those in most general use, where clay dust or flint dust is largely created, and to show you how each of these can now be conducted so as to reduce its dangers to a minimum.

Here I must diverge for a moment from my direct course to enter a *caveat* against the oft-repeated statement that English pottery workshops are more dusty, and therefore more inimical to health than the corresponding workshops in foreign countries. My own experience, which is probably as extensive as that of any living person, is entirely contradictory to any such idea; and I may remind you that Dr. Oliver, who was despatched by the Home Office to examine into the hygienic conditions of the French pottery industry,* found that the workshops of Limoges were more unhealthy, from this point of view, than those he had visited in Staffordshire.

As illustrations of typically dusty processes in English pottery manufacture I propose to consider—

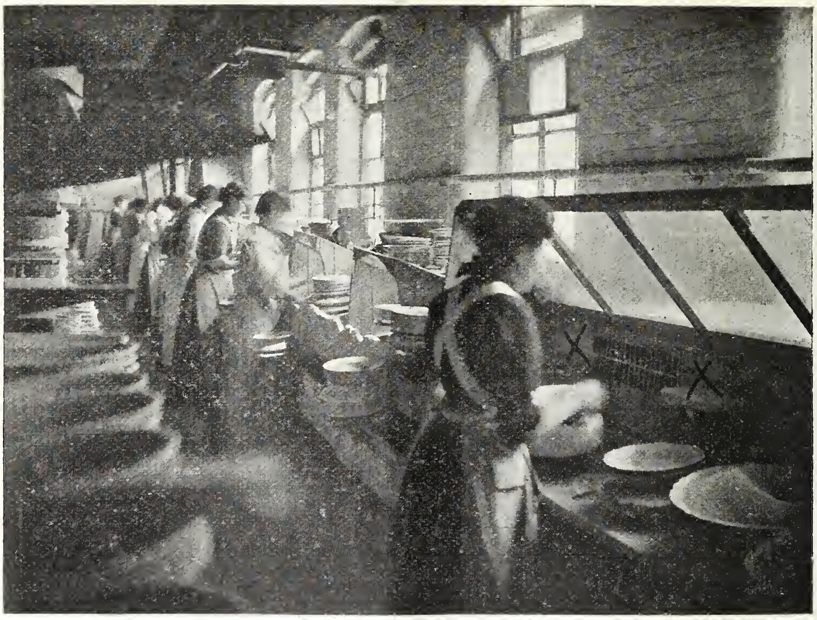
(*a*.) The "fettling" or finishing of earthenware plates, dishes, and similar articles;

(*b*.) The creation of dust in the grinding of clay, and the compression of that dust into tiles, in the ordinary process of tile making;

(*c*.) "China scouring," in which flint dust has to be removed from the china ware after its first firing.

(*a*.) *Fettling or Finishing of Clay Wares.*—By the kindness of some of my friends I have here a number of earthenware dinner plates in the clay state just as they come from the plaster moulds on which they have been formed. You will see how ragged and uneven the edges of the plates are, and you will realise that in order to produce the smooth perfect edge necessary for use those rough edges must be pared down, smoothed and rounded. This fettling or finishing may be conducted in a variety of ways, but in every case dust is at once produced, as you see when I attempt to smooth one of the plates before you. Such clay dust is by no means gritty or sharp, and it is certain that it cannot be as dangerous as the motor-car dust we are all becoming too familiar with—but no one would consider it healthy to work in a continual cloud of dust, and I now propose to illustrate, by photographs of a series of workshops, thrown upon the screen, some of the devices that have been

FIG. 2.



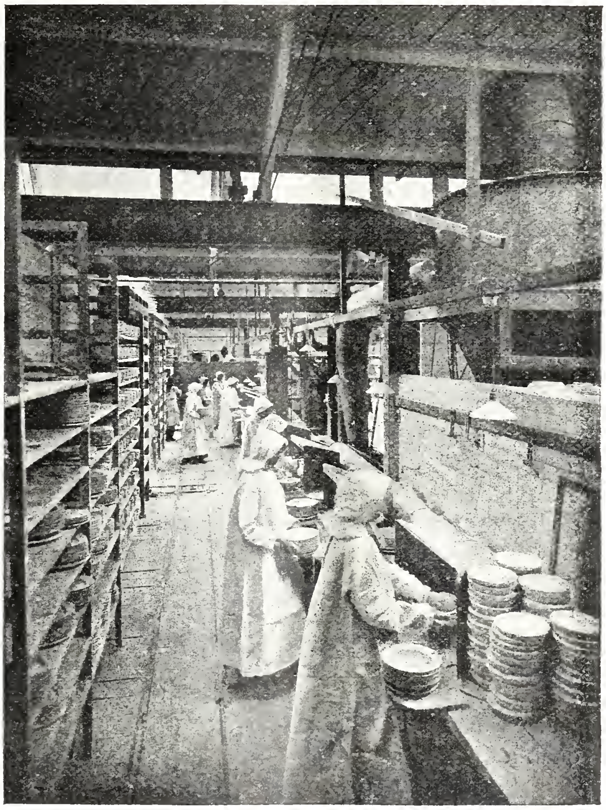
WORKSHOP. (W. H. Grindley and Co., Tunstall.)

* See Dr. Oliver. Report on the Pottery Industry in France (C. 9526), 1899.

introduced for dealing with this situation. Naturally enough, individual potters have attacked the problem in various ways, for the circumstances and conditions vary from factory to factory. Some of the appliances I shall show are not entirely satisfactory, while others seem to me about as perfect as it is possible to make them; and I am hopeful that one result of my lecture may be to spread among my fellow manufacturers, a better knowledge of what has been done in this direction. The principle of all methods of dealing with dust is the same, viz., that as near as possible to the spot where the dust is created, there should be an opening into a trough or duct, communicating with a fan of sufficient power to create a current of air capable of drawing such dust away from the face of the worker and removing it from the room. Every device for this purpose must be judged by its efficiency in this direction, and one must point out at once that in many installations, especially the earlier ones, there were two patent defects:—(1) The opening of the fan ducts were not near enough to the work, and a certain amount of the finest dust was allowed to diffuse itself into the air of the workshop, and (2) the currents of air were not powerful enough for their purpose.

I will first illustrate one of these inefficient methods (see Fig. 1, p. 495). While even an imperfect installation like this is a great improvement on the old conditions under which the dust was allowed to float in the atmosphere of the room and no special attempts were made to remove it, a glance at the photograph will show that the openings into the fan ducts are too small in area, and are too far removed from the point where the dust originated. It is useless to go to the expense of installing fans and other appliances unless arrangements are made to deal with the dust at or very near to its point of origin.

FIG. 3.



WORKSHOP. (Pountney and Co., Bristol.)

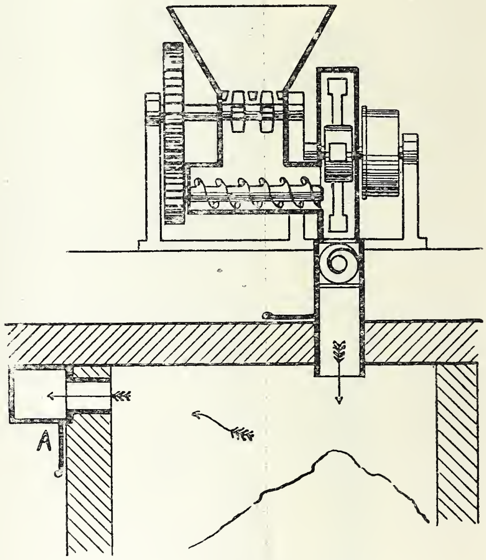
I now show an arrangement (Fig. 2) in the factory of Grindley and Co. at Tunstall, where these conditions are observed and where the

apparatus is a perfect success. The whirler or revolving stand on which the plates are placed to be finished actually turns in the fan-opening and is hooded round in such a way that all the dust is drawn away from the operative and directly out of the room. Another point of interest in this photograph is that at the extreme right is seen the modification introduced for dealing with oval dishes and other pieces larger than ordinary plates. [A number of other arrangements were shown on the screen and explained.]

The most perfect installation of this kind that I am acquainted with is shown in Fig. 3, illustrating one of the workrooms in the new factory of Pountney and Co. at Bristol. The fan ducts are very large, and as powerful fans are used the volume of air drawn over the working place is relatively great, whilst the openings are most suitably placed for ensuring that the dust is completely captured and sucked away.

(*b*.) *The Grinding of Clay into Dust, and its Compression into Tiles*.—Before 1850 tiles were always shaped from moist plastic clay like any other piece of pottery, but, about that time, Mintons introduced the present plan of drying the plastic clay, grinding it to dust, and compressing the dust into tiles under a die worked by a powerful press. At the present time this process is largely used in all civilised countries for making not only tiles but many other articles, such as the little complex pieces of pottery used for electrical purposes, of which a number are shown upon the table. It will be at once apparent that when clay is dried and then ground into dust we have one of the dusty processes *par excellence*. The modern method, especially where large quantities of dry clay have to be ground, is to pass the clay through a disintegrator. Many types of disintegrators are in use, but one of the best and simplest is that shown, in diagrammatic section, by Fig. 4, where the roughly broken lumps of clay are delivered into a drum in which steel beaters are driven round at about 2,000 revolutions per minute, and the clay is forced through steel gratings in the lower part of the drum, falling into a closed room or vault below. The general practice has been to keep the vault tightly closed, and while the greater part of the dust falls down and remains quiescent the finer particles often find their way back up through the machine and envelope the man shovelling the clay in a cloud of dust. I have myself seen men at work in a room where man and machine were almost invisible from a distance of 10 to 12 feet. On our own works my brother devised many years ago a perfect remedy based on the observation that the rapidly running disintegrator acts also as a powerful fan. Fig. 4 enables me to make the method clear. The dust falls from the disintegrator into the vault in a rapid stream, partly impelled by the current of air set up by the revolving beaters. If the vault is tightly closed there is no vent for the dust-laden air, which from time to time escapes back into the room through the machine. If, however, a wooden trough be attached to the outer wall of

FIG. 4.

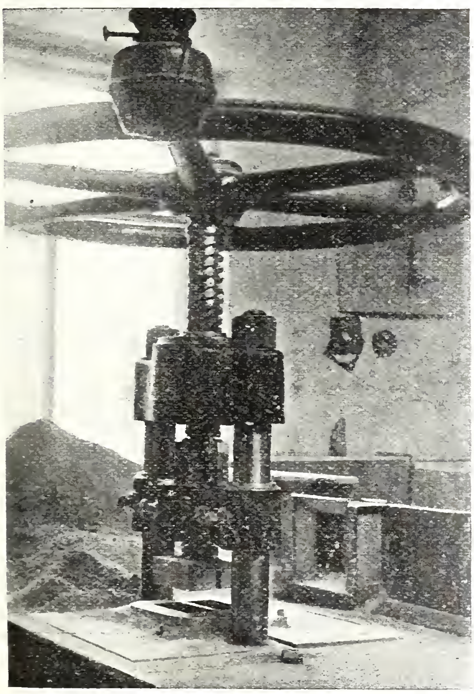


CLAY-GRINDING MACHINE.
(Pilkington's, Clifton Junction.)

the vault, communicating with it by a sliding door, as shown at A, the surplus air escapes through this trough and can be conducted to the top or the outside of the building so that every trace of dust is removed from the workroom. I may, perhaps, be excused for dwelling a little on this device because I have more than once found in practice that problems of dust removal and ventilation which seemed at first sight to involve costly operations of plant could be effectually solved by methods as simple and direct as this. [Here two photographs were thrown on the screen side by side showing the dust-fog produced when the opening at A was closed, in contradistinction to the clear atmosphere when the apparatus was properly arranged.]

With regard to the actual shaping of tiles and other articles from the clay-dust, every time the die is forced down in the press to stamp the dust into a coherent mass, the puff of escaping air carries with it a little fine dust. Ordinarily no notice is taken of this, and the atmosphere of the tile-press shop soon becomes dust-fogged. In our own, and in some other works in the country, fans have also been used in such a way that each little puff of fine dust is immediately drawn away on the opposite side of the press from where the worker

Fig. 5.



Tile Press with Dust Exhaust.
(Pilkington's, Clifton Junction.)

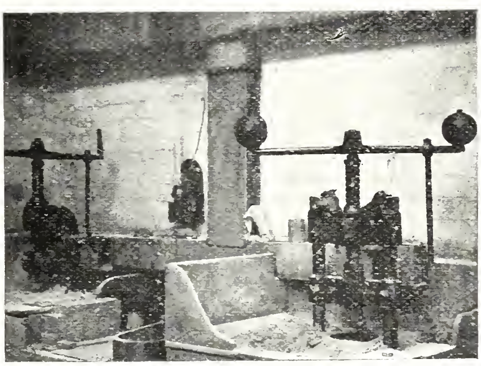
stands, and not only is the dust removed from the room, but the room is at the same time effectively ventilated. Figs. 5 and 6 illustrate the method used at our works at Clifton Junction. In each case the figures show only parts of a large scheme, but they are sufficient to indicate how the ducts from a series of presses can be coupled up to one powerful fan, which serves for the whole of a large workshop.

A difficulty often encountered in the past in dealing with dusty processes in certain pottery workshops lay in the fact that, as no steam driven machinery was used, there was no readily available power. Fortunately electrical power is now generally available, and it certainly enables fans to be erected and driven in situations where any other form of power would have been costly or even unattainable.

(*c*.)—*China Scouring*.—The dusty processes already described are concerned only with the dust of potters' clay, which, as I have said, is far less injurious than the dust of hard mineral substances like sandstone, flint, or granite. We have now to consider an occupation in which one of these hard, sharp, mineral dusts is created, viz., the dust of flint. May I explain what "china scouring" is and how the flint dust arises?

English china is a species of pottery quite distinct from Chinese, French, or German porcelain. The material from which your china cups, saucers, plates, or vases are made

Fig. 6.



Tile Presses with Dust Exhaust.
(Pilkington's, Clifton Junction.)

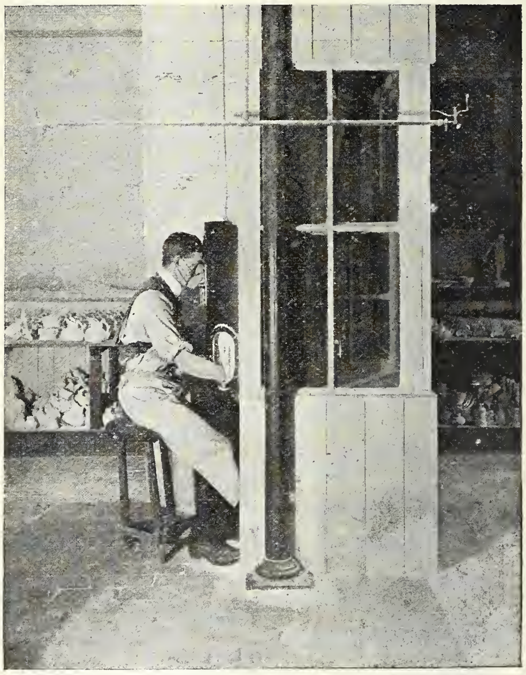
is compounded of kaolin, felspathic stone, and calcined bone-ash, all reduced to a state of minute sub-division and intimately mixed. To fire articles fashioned from this mixture into translucent china, the temperature must be so high that they are almost on the point of softening and going out of shape. To avoid disastrous loss from such causes the articles, especially saucers, plates, and dishes, are bedded in finely-ground flint powder in the saggers or fireclay boxes in which they are fired. When the pieces are removed from these boxes at the finish of the firing it is found that they are covered with a coating of flint dust, which needs to be brushed or polished off with stiff brushes or sand-paper, &c. For many years now it has been customary to use fans for removing the dust from the revolving brushes; but before that time "china scouring" was rightly considered as the most dangerous of all the potters' dusty

processes; flint dust being from its very nature much more injurious to the lungs than clay dust. Fortunately I am able to demonstrate the successive steps by which this occupation, only a few years ago the most dangerous to health in the pottery works of this country, has been improved, until to-day appliances are in use which entirely remove the danger. I throw on the screen a slide showing the arrangements of the china scouring shops at the Burslem factory of Messrs. Doulton and Co. as it existed some ten years ago. These arrangements were then considered so excellent that they were illustrated in the report of the Chief Inspector of Factories for 1899.* I need not say that Messrs. Doulton have been among those English manufacturers who have paid great attention to the health of their workpeople, and have stinted neither money nor enterprise in effecting improvements towards this end. The gist of this method of china scouring, which we may call the first improved method, is that the revolving brushes for removing the skin of flint from the fired china are hooded, each hood being connected with a general fan, and as far as possible no brushing is done except in the vicinity of the fan openings. Many manufacturers during the last ten years spent considerable sums of money in the erection of plants of this kind and yet none of us were satisfied, because even at the best it was difficult to get rid of all the flint dust by such means, and until that could be done it was impossible to cease from further experiments.

An important new departure was taken by the Worcester Royal Porcelain Company, also about ten years ago, in applying the principle of the well-known "sand-blast" to china scouring. I have now on the screen a diagrammatic representation of how a blast of sand was applied to this purpose, and in the next slide you will see the operator at work. (Fig. 7.) I have often seen this machine in use and, so far as safe-guarding the operative, it acts perfectly; but Mr. Evans, the managing director of the Worcester works, tells me they find it much more useful in scouring fancy ornamental articles than for getting through the heavy work of scouring tableware which is, after all, the main product at most of the china factories in this country. Another drawback to the sand-blast apparatus, as introduced at Worcester, has been the difficulty of getting rid of the finest dust (note that it is necessary for the operator to wear a respirator) and the finest dust is probably the most dangerous.

Within the last two years Aynsley and Co., of Longton, have installed in their works a much improved form of sand-blast where the articles to be scoured are passed twice through the machine on travelling bands, so that they are completely scoured on both sides, and the operation is conducted in such a way that the women in charge are entirely protected from the flint dust which is exhausted

Fig. 7.



China Scouring by Sand Blast.
(Royal Worcester Porcelain Works.)

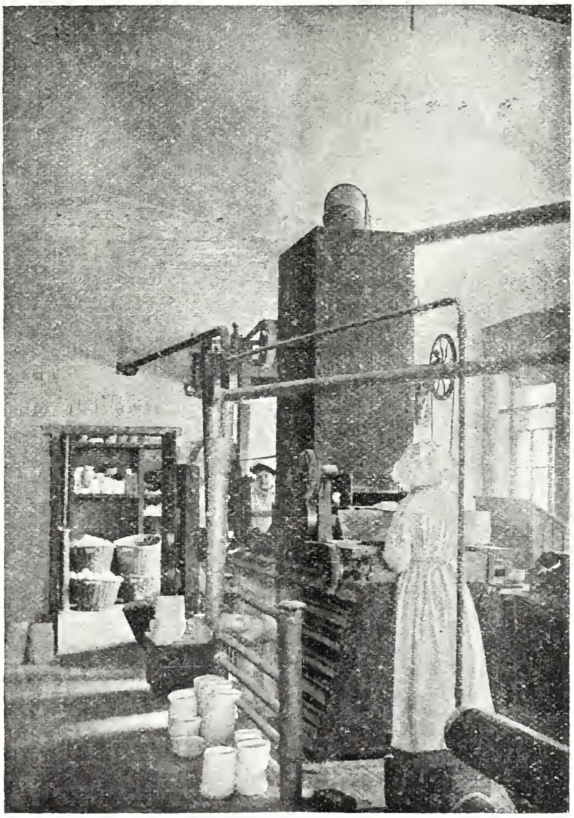
by a powerful fan (see Fig. 8). I am informed by Mr. John Aynsley that he is perfectly satisfied with the working of this machine, for not only is the scouring well done, but there is no escape of dust into the air of the room.

Within the last fifteen months the problem has been attacked in another way and, as far as we can see, has been finally disposed of. Most of you will be familiar with the simple machine known as the "rumbler," used in engineering workshops for cleaning castings, &c. An engineer living in Staffordshire, Mr. Wainford, hit upon the ingenious idea of applying the same principle to china scouring, and preliminary experiments, carried out at Messrs. Doulton's works at Burslem, demonstrated that china-ware might be scoured by

* See plate opp. p. 152, Report of Chief Inspector of Factories for 1899. Cd. 223, 1900.

the friction of fragments of broken china in a revolving drum. At first, the method, though very good for doing the actual scouring, presented the difficulty that when the ware had been scoured it came from the machine coated with fine dust, which in turn must be removed by brushing, and this, of course, involved a certain amount of risk. Mr. Hartley, of Stoke, a potters' engineer of great skill, hit on the idea of coupling the machine to a fan so that can be removed effectually scoured. I consider this invention a remarkable one, for it is applicable to the scouring of every kind of biscuit china; it is economical in use as it replaces a considerable amount of labour, and it effectually disposes of the dust, and therefore of the danger. Although the machine has only been on the market for a few months, I have before me a long list of English china works where it has already been adopted; while I am

Fig. 8.



China Scouring by Sand Blast. (Aynsley and Co., Longton.)

air could be drawn through it as it revolved and the dust automatically and perfectly removed without entering the room at all.

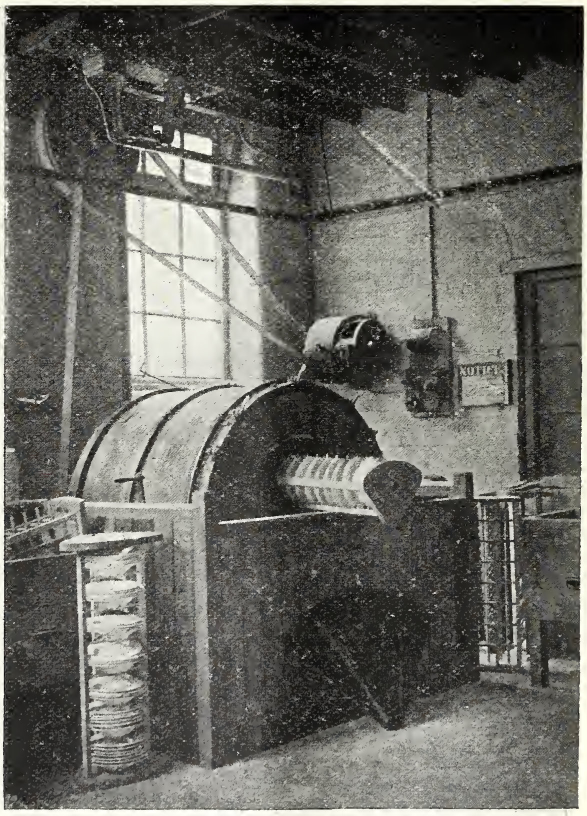
I have now on the screen a photograph of one of these machines being charged for work (Fig. 9). The unscoured china-ware is placed in skeleton racks of wood, which are made to slide into sections of the drum. A quantity of broken fragments of china is put into the machine; the drum is closed, and is set revolving slowly, when the friction of the fragments polishes off the flint dust without damage to the ware, and in about two hours the ware also glad to see that orders have been placed for these machines by certain Continental firms, so that, as in so many other cases, the Staffordshire potteries are leading the way in the introduction of new machinery for potters. On the table are a number of pieces of "unscoured" china with the adherent flint dust, which will show you how firmly attached the coating is, and that a certain amount of force is required to remove it; also a similar set of pieces that have been scoured in one of these machines. The latter are exactly as they were when taken from the machine, and you

will be able to examine them afterwards, when you will observe that they are perfectly smooth and free from every trace of grit or dust.

Minor difficulties associated with flint dust in the firing of china arise in connection with the processes of "flat-knocking" and "flint-sifting," but so few workpeople are engaged in these departments that I can do no more than refer to them. The same remedy must be applied in these cases also, viz., the introduction of methods for removing the fine flint dust so that it shall not be breathed by the operatives.

Before leaving that branch of my subject which deals with the dangers involved in the shaping or finishing of clay wares and the scouring of china, I must refer to some questions of a general nature concerning potters' workshops. I read regularly, with very great interest and sympathy, the accounts of the inspectors of factories dealing with our industry, as they appear in the annual reports of the Chief Inspector. For some years now these reports have laid great stress on the high temperatures found in pottery workshops and the inadequacy of their ventilation. I want to commend their remarks to the workpeople as well as the employers, for my experience as a works manager has convinced me that in many cases the trouble arises quite as much from the workpeople themselves as from any other cause. Take the simple case of women decorators—their work is of a sedentary character, involving little muscular exertion, and they insist before everything that their workrooms shall be at a temperature that would be unbearable under other conditions. The question in their case is a fairly simple one, but it becomes much more complicated when we have to deal with drying-rooms or stoves, or with the "mangles" of various types used to dry the ware at different stages of manufacture. Again I must point out the impossibility, as it seems to me,

Fig. 9.



China Scouring by "Rumbler."
(Doulton and Co., Burslem; Wileman and Co., Fenton, &c.)

of framing any simple and definite mode of rules which shall cover all the varying conditions of the different branches of the pottery trade. Certain drying operations can and must be conducted rapidly; others need to be carried on slowly—so that each manufacturer may have to deal with a different set of conditions. Taking this for granted I must add that the usual systems of drying used in the majority of potteries are not very enlightened or scientific. The old idea seemed to be that the drying should be conducted at a high temperature in a confined space, whereas everyone should know that the first principle in such methods is to pass sufficient volumes of dry air, and not necessarily very hot air, over and among the articles to be dried. Certainly everyone who has to deal with these problems can only reach a satisfactory result by working in the direction of using large volumes of air at a lower temperature, in opposition to the old plan of small volumes of air at a higher temperature. While I am on this point I should like to say that I think the whole question of the ventilation of potters' workshops has not received sufficient attention either from manufacturers or workpeople. Where ventilation is arranged for, the usual plan is to extract the air from the top of the room, either by natural or artificial means, and to bring it in near the floor. It would be a great improvement if the air could be admitted above the heads of the workpeople and taken out just above the floor level. Not only would a purer atmosphere be obtained in this way, but the dust in every case would be drawn downwards, which would be a tremendous added gain. I refer especially to those workshops in which a small amount of dust is created at irregular intervals so that special fans for dealing with it are unnecessary.

Surely, also, it is not too much to ask that, when improved methods of ventilation or fans for the removal of dust are introduced into workshops, the operatives should be willing to give them a fair trial. Up to now it has been too often the case that such improvements are either resented or misused by the very people for whose benefit they have been previously designed.

Plumbism among Pottery Workers.

Having considered as fully as possible within the time at our disposal the questions of mineral dust pure and simple, we must now turn to the vexed questions arising from the use of lead compounds in English pottery glazes. Everyone here is aware of the great public outcry that arose some years ago on the question of plumbism among pottery workers. Many well-meaning and philanthropic people, unable or unwilling to understand the difficult technical processes involved in glazing pottery, advocated the entire abolition of lead in glazes or colours, and even went so far as to say that English pottery manufacturers, as a body, were callously indifferent to the well-being of their workpeople, and only used lead on account of its cheapness. Such ideas are radically erroneous and unfair. Leaving aside for a moment the question as to whether lead compounds are necessary to the English potter, as he contends, let us endeavour to get a fair idea as to what plumbism among pottery workers means both qualitatively and quantitatively.

A great deal of misconception is prevalent as to what is implied by an attack of plumbism or lead poisoning. The very use of the word "poisoning" conveys to most of us an idea of something fatal; yet it is only a small proportion of the plumbic cases among pottery workers that have fatal or even serious consequences. Dr. Oliver, in the preceding lecture of this series, described the medical aspects of the disease, and stated clearly the difference between mild and severe cases. In certain industries the proportion of severe cases is large, but among pottery workers the reverse is true. In the opinion of those medical men most conversant with the ailments of pottery workers, from the late Dr. Arlidge to the present certifying surgeons in the Potteries, the great majority of the cases arising in this industry are mild in type and are readily curable by suitable treatment.

Colic, constipation, abdominal pains, and anæmia are the symptoms in more that 50 per cent. of these cases, and if taken in time, as such cases now are under the system of monthly medical examination of lead workers, restoration to health is generally complete in one or two months at the outside. A further group of cases, at least 30 per cent. of the whole, though presenting more severe symptoms, are still responsive to treatment and can also be cured, though the health may not always be completely re-established. The smallest proportion of cases, under 20 per cent. of the whole, are those where the absorption of lead has produced serious disturbance of the nervous system, and these grave attacks may result in blindness, paralysis, or

untimely death. This condition of affairs, though serious enough, bears no resemblance to the lurid pictures that have been drawn of the state of affairs in the Potteries, and we now have to consider what reasoned steps have been taken, or can be taken, to deal with it in such a way as to effectually remove even this danger from our workers.

Turning, now, to the quantitative aspect of the question, I have already mentioned that of the 73,000 workers employed in the whole industry in Great Britain, only some 6,700 are employed in processes where they run any risk of plumbism by reason of their avocation. These workers follow many different occupations, as dippers, ware-cleaners, glost-placers, majolica painters, ground-layers, &c.—working either on earthenware, china, tiles, electrical fittings, teapots, or some other species of pottery. The exact nature of the employment and the amount of risk run vary according to the special calling and to the kind of pottery made. Some glazes contain more lead than others; some kinds of ware need to be handled in a way that may either diminish or accentuate the risk; so that the problem of finding an efficient remedy is never a simple one. I will now, by a series of tabular statements, show what has taken place with regard to plumbism in the whole industry as a result of the special attention paid to it during the last twelve years or so. First we will put, side by side, all the reported cases; and precautions are taken by the Home Office that every case, however slight, shall be reported*:—

Table I.—Total Number of Cases of Plumbism in Potteries.

	1906.	1900.	1896.
Numbers employed in dangerous processes—			
Males	4,394	4,224	4,200
Females	2,300	2,148	2,040
Number of cases—			
Males	47	95	186
Females	60	105	236
Percentage of persons attacked—			
Males	1·1	2·2	5·2
Females	2·6	4·9	13·1

It is apparent from Table I. that while the number of lead workers employed in the scheduled occupations has risen from 6,240 in 1896, to 6,694 in 1906, the number of cases reported has fallen from 422 to 107 in the same period. I have taken the figures for the year 1896, 1900, and 1906, for the following reasons: The first complete returns were made in 1896; in 1900 we had the first effects of the improvement due to the Special Rules of 1898; and 1906 is the last year for which we have the complete returns. To show that 1906 is not an unfair year for this purpose, I now tabulate all the cases in the five years, 1902-1906 inclusive:—

Table II.—Cases in the Five Years, 1902-1906.

	1906.	1905.	1904.	1903.	1902.
Number of cases—					
Males	47	36	39	43	40
Females	60	48	67	54	47
Total number	107	84	106	97	87
Percentage ratio—					
Males	1·1	0·8	0·9	1·0	0·9
Females	2·6	2·1	2·9	2·3	2·2
Total	1·6	1·3	1·6	1·5	1·4

Mean of the Five Years.

Number of cases, 92·2. Percentage of cases, 1·5.

A first glance at these figures might lead one to assume that there had been no improvement since 1902; but before adopting that conclusion I must remind you that compensation for plumbism has been paid to pottery workers since 1902 under the award of Lord James of Hereford; and my only astonishment is that the number of reported cases has not shown a great increase in consequence, for plumbism, at all events in its earlier and simpler stages, presents no objective symptoms, and it is very difficult for a medical man to exclude lead as the source of anæmia, colic, abdominal pains, &c., when they are found in persons working with substances containing lead.

It is necessary to point out with regard to plumbism that, just as we found with the dangers arising from mineral dusts, the risk is very unevenly distributed among the different groups of workers. Fortunately it is this uneven distribution of the risks that has given us the clue as to where the danger really resides, and shows us what we must avoid if plumbism is to be effectually stamped out. I feel strongly that we potters may reasonably complain that medical men, interested in the question of plumbism, were a very long time in making up their minds as to the actual

* The statement is often made by irresponsible people that all the cases are not reported, and that the official returns are fallacious. I can find nothing to support such a view, and if one or two cases a year were omitted accidentally they are more than counterbalanced by reported cases where the plumbism is very doubtful.

modus operandi by which the lead enters the human system to do its mischievous work. In 1892, when the subject was first inquired into by a Home Office committee, we were told that lead was absorbed through the skin. If such were the case there can be no doubt that nothing short of the discontinuance of the use of lead compounds would ever stamp out plumbism among pottery workers. We know, however, that whatever may be the case in other trades, the compounds of lead used in potteries are not absorbed by the skin, and that we must now concentrate our attention on what may pass into the body by way of the nostrils or the mouth. I do not hesitate to say that this idea of skin absorption, which has I believe been finally abandoned by all the best authorities, delayed the settlement of the question, by diverting attention from the really vital point, viz., that if you can prevent the workers taking in, at the nose or mouth, dust containing lead compounds, you can practically abolish the source of plumbism.

Let us now look into the distribution of attacks of plumbism, from the mildest to the most severe, among all the different groups of workers in the processes scheduled as dangerous. First, I will give the figures relating to the important branches of employment known as "dipping and ware-cleaning." The dipping of pottery, in English practice, means the coating of the ware after its first firing with a skin of the glaze-material. This is effected by plunging the article, which is more or less porous at this stage, into a fluid bath of the glazing material held in suspension in water. In dipping small articles only the hand, or even the tips of the fingers, need be inserted in this fluid; but, with larger pieces, the whole forearm or more may have to be repeatedly immersed. If the lead compounds used in glazes entered the system by absorption through the skin then no calling could be so dangerous as that of a dipper, but the tables show that the dipper's risk is less and not greater than that of some other callings.

TABLE III.—DIPPERS.

	1906.	1900.	1906.
Numbers employed—			
Males	781	754	722
Females	132	103	90
Total	913	852	812
Attack rate (per cent.)—			
Males	2·9	4·8	8·2
Females	3·8	4·9	8·6

When the articles have been dipped the glaze coating is never perfectly even, and, according to the kind of ware, a certain amount of smoothing, trimming or levelling of the glaze-coat must be done. In certain kinds of pottery this "ware-cleaning" is either unnecessary or is so slight that it can be done at once before the glaze is dry, in which case the ware-cleaning is not a risky operation. Here, for instance, is a finished Rockingham teapot, and another one with its coating of glaze just ready for firing—you see how the glaze is welted and uneven, but no ware-cleaning is necessary because the glaze is so fusible that all these inequalities will disappear in the firing; and because there is no ware-cleaning and therefore no glaze dust created in this branch of the industry it is found that even with glazes exceedingly rich in lead the attack rate is infinitesimal. With china-ware, or the vitreous pottery of which electrical fittings are made, the case is very different. The glazes used in these cases contain much less lead, and are consequently not so fluid when they are fired, whilst exceptionally perfect finish is demanded. A very considerable amount of ware-cleaning is therefore necessary, and the risk is correspondingly increased, because glaze cannot be cleaned or trimmed without the creation of dust when once it has been dried. Here before you is a large collection of pieces of various kinds, some just as they have been dipped, others after they have been trimmed. Consider for a moment this group of small articles, comprising parts of electrical switches, fuses, colour pans, &c., and you can see at a glance what an amount of cleaning is necessary to render the glaze-coat sufficiently uniform. The holes in these plugs and switche sare blocked with glaze, and must be pierced with an iron tool, so that, after firing, the hole is ready to receive a metal screw. These little colour pans need a very thin and even coat of glaze, and the rough welts must be rubbed down on a damp flannel before they are fit to be fired. So, too, with china teacups, plates, teapots, &c., a considerable amount of ware-cleaning is unavoidable. Except in those cases where the cleaning can be finished before the glaze has dried, it is obvious that ware-cleaning creates dust—and it is this dust, small in amount and dangerous only because it contains lead compounds, which causes all the mischief. In any case, ware-cleaning is a more dangerous occupation than dipping, as the figures show.

TABLE IV.—DIPPERS ASSISTANTS AND WARE-CLEANERS.

	1906.		1900.		1896.	
	M.	F.	M.	F.	M.	F.
Numbers employed—						
Dippers assistants	454	387	482	365	576	187
Ware cleaners	101	404	100	461	130	516
Total	555	791	582	826	706	703
Attack rate (per cent.)						
Dippers assistants ..	0·9	4·9	1·9	6·0	3·6	15·0
Ware cleaners	1·0	4·1	6·0	9·5	?	12·5

Another large and important group of operatives is that known as "glost-placers." These are the men and youths who place the ware, after it has been coated with glaze and trimmed, in the saggers or other receptacles where the pieces are again fired in order to melt the glaze so as to produce the brilliant glossy surface we are all so familiar with.

Table V. gives us the information concerning this group.

TABLE V.—GLOST-PLACERS.

Numbers employed in 1906—Males 2,344; females 97.
Attack rate (per cent):—

	Males.	Females.		
1906	0·6	1·0	=	1 case.
1900	1·6	1·4	=	1 case.*
1896	2·9	2·0	=	1 case.*

It is very satisfactory to see that in this large group of workers the percentage of cases relative to the numbers employed fell from 2·9 to 0·6, or from 29 cases in 1,000 workers to 6 cases among 1,000 workers. Speaking from my experience as a manufacturer, I say emphatically that where a man is a glost-placer pure and simple, and not a ware-cleaner as well, he ought never to suffer from plumbism at all. If he does suffer, it is entirely the result of his own carelessness in putting his pipe or food to his mouth while his hands are covered with the glaze rubbed off in handling the ware.

We have now dealt with the occupations of over 4,700 out of a total of 6,700 workers. The remaining 2,000 or so are occupied in a variety of callings, which may be classified as follows:—

* In these two years the number of females employed were 103 and 50 respectively.

TABLE VI.—MISCELLANEOUS OCCUPATIONS.

	Numbers Employ'd		Attack Rate (per cent.)					
			1906.		1900.		1896.	
	M.	F.	M.	F.	M.	F.	M.	F.
Majolica painters ...	30	557	—	1·3	—	1 6	—	12·8
Ground layers ...	49	200	—	1·0	1·7	2·0	13·0	13·0
Colour dusters ..	9	150	—	—	—	4·1	62·5	20·8
Enamel, colour, & glaze blowers	36	215	—	3·3	3·6	2·5	Not known	
Sundry occupations	214	97	—	—	1·7	15·1	23·2	5·3

Here, again, we have the same gratifying steady diminution in the number of cases occurring in all these varied branches of the industry; but the figures show besides, to anyone familiar with what has been done by Home Office regulation and by the initiative of manufacturers, how the introduction of fans for dealing with dust, the greater care and cleanliness imposed on all operatives, and the influence of the monthly medical examination of lead workers, have been entirely justified, and should be strengthened or carried further where occasion requires. Gathering together all the information that is to be derived from the official figures, the fact is clearly established that the risks are greatest in those processes where lead dust is created, and that in these callings, where fans have been applied to remove the dust, the danger has well-nigh disappeared, and will entirely do so with a better understanding, by all concerned, of the exact source of the danger.

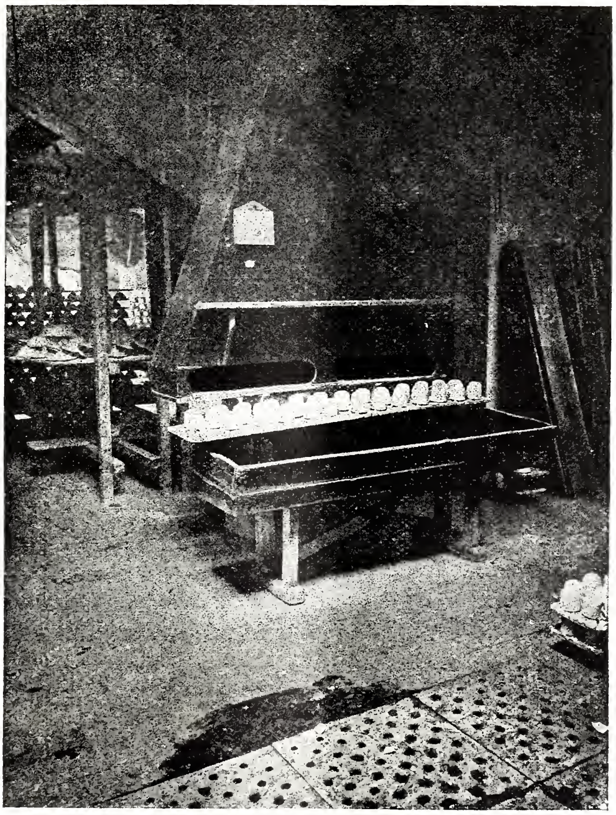
The first care of all lead workers, and of the employers and managers responsible for them, should be that splashing of glaze about in any way so that it can form dry patches on floors, walls or benches, must be carefully avoided; for these dry patches may be trodden or brushed into dust, which becomes diffused in the air of the work-room, and so passed into the nose or mouth, to be eventually swallowed. In all dipping-houses, placing-shops, and similar rooms, the floors should be tiled or concreted, so that they can be washed down and not swept; all work-boards and benches should be wiped down with a sponge or wet cloth in the same way; everything done, in a word, to avoid the creation of dust. Workers whose hands become dusty or wet with glaze should rigorously observe the regulations which forbid smoking or partaking of food or drink with unwashed hands, as contravention of this rule seems to be the only reason why plumbism has not already been wiped out in those callings where no dust need be created. It is an

unpleasant duty to bring a charge of carelessness in these respects against the workpeople, but every manufacturer knows how difficult it is to prevail on his people to observe even these simple precautions; and the factory inspectors and certifying surgeons have frequently drawn attention, in their official reports, to the difficulty of getting the workpeople to obey precautions devised for their own protection. Another point, frequently reiterated by Dr. Oliver in his writings, which cannot be too strongly urged on lead workers, is that for them alcohol should be looked upon as a poison.

We must now consider what can be done to further improve the conditions in those operations such as ware cleaning, colour dusting, and colour and glaze blowing, where lead dusts necessarily arise as a part of the process. The problems are really the same as those already met with in dealing with clay dust, but the application has to be varied because the amount of dust made in ware cleaning is relatively small, and yet it is necessary to secure its complete exhaustion from the work-room. The actual devices used must, of course, vary with the particular conditions that have to be met—the arrangements suitable in the ware cleaning, say of earthenware dinner plates, where everything has to be done with great rapidity, and the cleaning of china plates or electrical fittings, where the greatest care is necessary, will illustrate this.

I will throw on the screen arrangements in use at some of the largest earthenware works, viz., at some of the works of Johnson Brothers, Hanley; Grindley and Co., Tunstall; and Doulton's, Burslem. In these cases the ware as it is dipped is placed on the shelves of a machine called a "mangle," and it is then passed automatically through a drying chamber, so that by the time it reaches the women ware-cleaners it is dry enough to be trimmed and smoothed. This cleaning takes place over a water-trough, so that any particles of glaze of sensible size fall into the water

Fig. 10.



Corner of a Ware-cleaning Room. (Johnson Brothers, Hanley.)

and are safely retained there, while, behind the water-trough, there are large openings into the fan ducts connected with a fan powerful enough to draw away all the fine dust. (See Fig. 10.)

The arrangements for the ware-cleaning of small articles, which need a great deal of care and handling, are necessarily different. The ware-cleaning rooms of Taylor, Tunnicliffe and Co., of Hanley, are the best of the kind that I know, and by the kindness of Mr. Taylor I am able to illustrate them fully. The women workers sit around the room at convenient distances, each one before a large photographic dish, shaped in front so as to fit to the body of the worker. This dish contains water, and all the larger particles of glaze fall into it and are retained. Immediately behind and above the dish is an opening into a large fan duct, so that the fine dust is also carried away; and the room is always kept in a condition of great cleanliness. (See Figs. 11 and 12.)

Fig. 11.

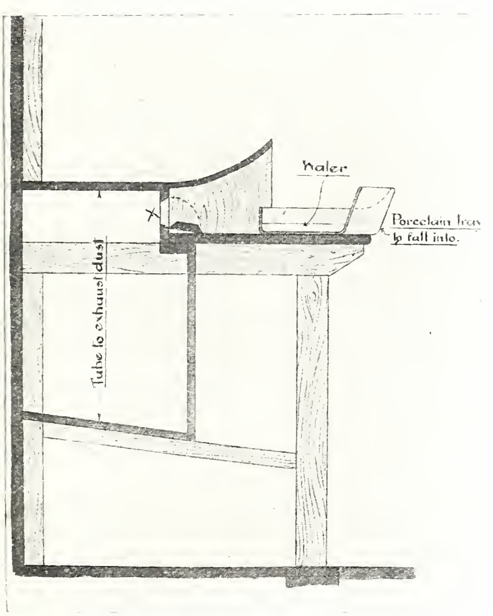
Ware-cleaning Room. (Taylor, Tunnicliffe and Co., Hanley.)

It is absolutely necessary that the fans intended to deal with lead dust shall be large enough to create currents of air in excess of any apparent need, for glaze dust does not arise in such quantities as to be dangerous as dust *per se*, the danger comes from its toxic character. This is particularly true in those processes like ground-laying, colour-dusting, glaze, or colour-blowing, &c., where the lead compounds are used in the form of dust or spray. In aerographing and colour-blowing, where the colour or glaze is blown on to the ware by compressed air, there is an actual rebound of particles toward the worker, and I am convinced that in many new installations this has not been sufficiently guarded against. Either a hanging glass screen should be interposed between the worker and the work, or the fan should be of such a character as to be able to deal with the large volumes of air forced in the openings by the blowing apparatus.

I have trespassed on your time to an inordinate degree, so that I cannot enter into further details to-night—yet, you will naturally expect me to say something as to the alternative method that has been advocated by those outside the industry, as a means of ridding the Potteries of the risks of plumbism. I mean the extreme plan of abolishing the use of lead in glazes. Could that be done, the difficulty would disappear, but in the light of our knowledge, any such method is impossible. There are many forms of pottery, such as salt-glazed stonewares and hard-paste porcelain, which can be glazed without lead compounds. Salt-glazed stonewares are largely made in

England, but hard-paste porcelain has never been successfully made here. The great bulk of our English products—earthenware, English china, tiles, electrical fittings, &c.—can only be satisfactorily glazed with glazes containing lead; and this is the experience of the potters of all the countries, either in Europe or America, where similar wares are manufactured. I must say, with the fullest sense of the responsibility of such a statement, that to talk of the possibility of using leadless glazes on the great bulk of the pottery made in this country, is simply to cherish a delusion.

FIG. 12.



SECTIONAL DRAWING OF ARRANGEMENTS IN ROOM SHOWN IN FIG. 11.

From every point of view it seems to me a retrograde step in these days of advancing knowledge to propose that our manufacturers should be prohibited from using the most suitable substance ever discovered for making the glazes they require, because there is danger to the health if the substance is carelessly or ignorantly used. The whole trend of the scientific conduct of the world's new industries, is to bring into use compounds of every kind, some of them highly explosive or poisonous; yet everyone, in such cases, recognises that the substances must be used —always under proper conditions This is the sound course to follow with our old industry also; everyone in it from the top to the bottom must be educated in the proper method of handling these substances, and manufacturers and workpeople alike must see that the working conditions are all that can be desired. I have shown conclusively how much has been done already—and in a comparatively short time. We now recognise clearly that in the use of lead as much as in the use of clay or flint, "Dust" is the enemy; and I am full of hope that we are within measurable distance of the time when the health risks of the pottery worker will be no greater than in any ordinary occupation.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 25th, 1908; SIR WILLIAM EMERSON, Past President R.I.B.A., in the chair.

The following candidates were proposed for election as members of the Society:—

Agbebi, Rev. Mojola, D.D., Lagos, West Africa.
Allen, Henry Edward, Assoc.I.M.M., Ashanti Goldfields Corporation, Limited, Obuasi, Gold Coast Colony, West Africa.
Belknap, Henry W., 31, Warren-street, Salem, Massachusetts, U.S.A.
Bird, Mrs. Charles Sumner, Endean, East Walpole, Massachusetts, U.S.A.
Carder, Frederick, Steuben Glass Works, Corning, New York State, U.S.A.
Esch, Vincent J., Architect's Office, Bengal-Nagpur Railway, 11, Garden Reach, Calcutta, India.
Gupta, K. G., 57, Tregunter-road, South Kensington, S.W.
Kilmorey, K. P., Earl of, 5, Aldford-street, Mayfair, W.
Lal, Rai Brij Behari, B.A., LL.B., Moradabad, United Provinces, India.
Power, William Mailes, Victoria Gallery, 123, Victoria-street, S.W.
Richards, Charles Henry, Garforth, Melrose-road, West-hill, S.W., and The Crotons, Coromandel P.O., South India.
Williams, John T., Brockhampton, Bromley-common, Kent.

The following candidates were balloted for and duly elected members of the Society:—

de Gruchy, Charles, Heathfield-lodge, Wandsworth-common, S.W.
Fighiera, Felix, 3A, Coleman-street, E.C.
Hill, Claude Hamilton Archer, C.I.E., The Residency, Udaipur, India.
Jones, Miss Constance Flood, 100, Grosvenor-road, S.W.
Leechman, George Barclay, 50, Campden-house-court, Kensington, W.

Lucas, T. Mackworth, F.S.S., 56, Moorgate-street, E.C., and Norton Lee, 169, East Dulwich-grove, S.E.

Mahmudabad, The Hon. Raja of (Ali Muhammad Khan), Mahmudabad District Sitapur, Oudh, India.

Pullen-Burry, Miss Bessie, 24, Prince's-square, Kensington-gardens, W.

Smith, Cyril, M.Inst.C.E., care of Herbert Allen, 31, Budge-row, E.C.

Tallberg, Professor Axel, A.R.E., Royal Academy of Arts, Stockholm, Sweden.

The paper read was—

RECENT IMPROVEMENTS IN DECORATORS' MATERIALS.

By Arthur Seymour Jennings.

Many improvements have been made in the materials and plant used by house painters and decorators during the last decade. My object to-night is to draw attention to some of the more important of these.

Paints.

Probably everyone here to-night is more or less interested in paint. Architects, engineers, and property owners are alike interested in the study of paints, not necessarily from a decorative point of view, but because of their value as preservatives of the wood, iron, stone, or other surface to which they are applied. Paint has been likened to insurance in the sense that the cost is a tax on property; but it is a very necessary one when the preservation of that property is taken into consideration.

Perhaps the most important development of comparatively recent date is the increase in the use of various white pigments other than pure white lead. For very many years white lead has held the premier position in the minds of the public as the base of all good paint, but investigations continued during the last ten years or more have shown conclusively that while white lead possesses excellent qualities in some respects, it is woefully deficient in others. It is not my desire to attack white lead, but to point out that its shortcomings may to a great extent be overcome by mixing it with other pigments. White lead possesses the advantage of having great "body" or opacity when ground in oil to form a paint, and this is an important quality, because when a paint is deficient in body an additional coat may be necessary in order to hide completely the surface to which it is applied. White lead works easily under the brush, forming when ground with oil something of the nature of a lead soap. On the other hand, it is poisonous and very susceptible to the action of sulphuretted gases as well as to the damaging effects of sea air. As sulphur is present in the atmosphere of all large towns it will be seen that white lead is by no means the ideal pigment that it is generally supposed to be. We may now consider what pigment can be recommended for use, either wholly or partially in place of white lead. Certainly the most important is zinc oxide, or as it is frequently called zinc white. This beautifully white pigment is used to a very large extent on the Continent and in America, and is rapidly increasing in popularity in this country. It is quite innocuous, the particles of which it is composed are very fine — a point of importance, to which I shall presently draw attention—it is not visibly affected by sulphurous fumes, and it may, unlike white lead, be mixed with any other pigment, or colour containing sulphur, without affecting them, or itself being affected. When ground in oil it forms a paint which, if properly applied, has been proved to be exceedingly durable, especially in those situations, such as the seashore and in smoky towns, which are so destructive to lead paints. For a surface that is to be finished white, it may be looked upon as the best pigment at the command of the decorator. In coloured paints it may be used as a base, as its durability is then equally of advantage, particularly so as the purity of the tints will be maintained better that when lead is used. The best grades of zinc oxide are quite white, while the lead is comparatively yellow.

The objections often urged against zinc oxide are that it is more costly than lead, that it is liable to crack, and that it is deficient in body. As to the cost, it certainly costs a few shillings per hundredweight more than lead, that is to say it is dearer, weight for weight, but when it is made into paint in a condition ready to be applied to the work by means of an ordinary painters' brush, it spreads very much further, or in other words it covers, weight for weight, a much greater surface. This is due to the fact that it is much lighter, and that it requires a much greater proportion of linseed oil than white lead will take, and also because of the relative fineness of its particles. Mr. J. Cruickshank Smith, in a paper read before the Institute of British Decorators, gave the covering capacity of 1 cwt. of white lead when mixed to a proper consistency for application at 800 square yards,

and of zinc oxide at 1,400 square yards. The same quantity of red lead he estimated would cover 600 square yards, and of iron oxide 1,100 square yards.

No doubt the use of zinc oxide would have even greater progress towards popularity in this country if painters knew better how to mix and apply it; and this brings me to a consideration of both of the objections urged against it, as already mentioned. If zinc is mixed in the same manner as lead it certainly will not show up to the same advantage. The custom of course is to add a fairly large proportion of paste or "patent driers" to the stiffly-ground lead and then to thin by adding linseed oil and turpentine, the latter perhaps somewhat liberally. This is emphatically *not* the way to mix zinc ready for application. Paste driers should not be used at all and turpentine very sparingly. If the work is to be finished white, refined pale boiled linseed oil should be used and then no driers will be necessary excepting in damp weather when a little zinc driers, usually consisting of borate of manganese, may be employed. The cracking of a film of zinc oxide paint which sometimes takes place has been shown by an eminent authority—Maximilian Toch of New York—to be due to the resin contained in ordinary turpentine; hence the sparing use of it which I have recommended. Toch suggests that white petroleum spirit which is rapidly coming into favour in place of turpentine, as I shall presently show, might be advantageously used in place of American turpentine in all paint made from pure zinc oxide.

Before leaving zinc oxide I should like to say a word concerning its "body." This, of course, refers to the actual opacity of a pigment when made into a paint, and varies largely in different pigments and according to the vehicle with which it is mixed. Thus chalk or whiting, when mixed with water, has an excellent body, and a single coat of distemper—which is, of course, mostly chalk—thoroughly covers and hides the surface to which it is applied. But if the whiting is ground in oil it is found to possess very little body indeed.

Both white lead and zinc oxide have very good body both in oil and water; hence, we have the artists' flake white and Chinese white. The question is as to how zinc can compare with lead when used in ordinary painting work. I have carefully made some experiments and can substantiate some statements made by Mr. Cruickshank Smith on this part of the subject. Mr. Smith found that a single coat of lead and zinc, painted out side by side on a board which had been painted with a broad line of black from end to end, proved that the lead had decidedly the best body. On the first coat, that is to say, the black band was not so much obscured in the case of the zinc as it was in that part of the board painted with lead. On the second coat there was very little to choose between the two, but possibly a little advantage in favour of the lead. In the third coat, however, the two were to all intents and purposes equal, and if there was a difference it was certainly in favour of the zinc. As most new woodwork receives at least three coats it will be seen that the relative deficiency of a single coat is not of much importance. The advantage of zinc oxide from a hygienic point of view—it being non-poisonous—is of course considerable.

Before passing to a consideration of mixed paints, I desire to draw attention to some other pigments which merit attention. We can pass over the earth colours, such as the ochres, siennas, Vandyke brown, Indian and Venetian red, &c., because their properties and values are generally well understood, and they do not properly come within the scope of my paper.

Lithopone, however, is a white pigment which is worthy of special mention. Although not a recent invention it has increased in use enormously in recent years—indeed, the demand for it during the past twelve months has exceeded the supply. The group of pigments of which lithopone is a type, were invented by J. B. Orr, in 1880, and were sold under various names, such as Orr's White, Charlton White, and various other arbitrary terms. Lithopone is the spelling usually adopted in this country, for that which comes from abroad, notably from Germany. In its earlier stages, there was some lack of uniformity in the production of this pigment, which led to unfortunate results, and for at least ten years past, and probably a much longer period, this want of uniformity has been wholly corrected. Lithopone—I give the generic term for obvious reasons—is a splendid example of a pigment which opens one's eyes to the value of pigments, other than white lead. It consists of 25 to 33 per cent. of zinc sulphide and 75 to 66 per cent. of barium sulphate, commonly known as barytes, a mineral which is, and has always been, largely used as an adulterant of white lead.

But the sulphate of barium contained in lithopone is in no sense an adulterant, as it forms part of the pigment itself. Another authority says:—"We have here an excellent example of a pigment containing 70 per cent. barium sulphate which may be regarded as perfectly pure and normal, and yet twenty-five years ago any pigment containing far less barium sulphate than lithopone, would have been regarded as adulterated. No man can reasonably state that barium sulphate is an adulterant to lithopone, for the obvious reason that it is a constituent part of the pigment." It is also very important to note that artificial sulphate of barium is a very different body from natural barytes although chemically they are the same. The latter has very little body, the former considerable.

Lithopone has excellent body and is very largely used for interior decorations. It is also used in the cheaper grade of enamel paints. It possesses a peculiar property of absorbing light and giving it out again. If mixed with linseed oil or varnish and exposed to the sunlight it turns grey, but when placed in the dark it returns to its normal white colour. This class of paints cannot be used in conjunction with lead paints, as the sulphur contained in the sulphide of zinc is likely to cause a change of colour. A case in point recently came to my notice in which a decorator gave a ceiling two coats of white lead paint mixed without adding oil, so as to dry flat. Upon this was applied a coat of a well-known white washable distemper, which is composed largely of lithopone, with the result that in a few weeks the white was much discoloured, no doubt due to the lead of the undercoats being antagonistic to the sulphur in the distemper.

Graphite is another pigment which is being used to a considerable extent in this country for the protection of iron. Graphite is not used alone, as it would produce too thin a film to give good protection, but when mixed with silica very good results are obtained. Graphite paints when dry give a very smooth and slippery surface just as would be expected from a material which is essentially the same as the ordinary so-called blacklead used for polishing stoves and in lead pencils. It is, however, different in physical structure. This slippery surface is somewhat disadvantageous when repainting, but it is probably due to it that the graphite paint lasts so long. It is well understood that all paint exposed to the elements are caused to decay largely by the agency of water. The rain gathering upon the surface carries with it acids, sulphur, &c., and these attack the paint. In the case, however, of graphite, the water is not retained, and even when applied to a surface in a horizontal position it will be found that the water will gather up in drops as though upon an oily surface.

In America, where flat roofs are so largely used, it is important to keep the tin protected by good paint, and graphite is used to a considerable extent for the purpose. Many painters have told me that the only objection they have to it is that it lasts too long.

Fast Reds.—I think I ought to say a word about the bright red pigments known as "fast reds" which are rapidly taking the place of quicksilver vermilion which, of course, is sulphide of mercury. Most of these are made from what are known as Para-nitraniline lake. These are precipitated on to a base but they cannot be mixed with white lead. The colour is very strong and as permanent as vermilion or even more so, and they are much cheaper. They are made in several different shades suitable for different purposes, and it appears likely that mercury vermilions will soon be driven from the market by them.

One of the fast reds on the market which is very popular and is largely used by post offices and railway companies for their signals, differs somewhat from those described above. It possesses the advantage of being permanent and very cheap as compared with vermilion. It is to be presumed that the agencies which adversely affect vermilion and its substitutes are acids, alkalies and sulphur. I am showing here examples of ordinary vermilionette in a solution of caustic potash and in alcohol. I am also showing the fast red to which I have referred to, in the same liquids, and it will be observed that while the ordinary vermilionette is practically destroyed by the alkali and the methylated spirit, the other is practically unaffected.

Greens.—In passing it may be mentioned too that very considerable improvements have of late been made in the manufacture of greens used by house decorators. Brunswick green, which has been so largely used, possesses the disadvantage that it quickly fades, but the series of greens are practically free from this defect and are moreover made in many pleasing and useful shades.

A large number of new processes for making white lead have been patented from time to time, but very few have proved to be commercial successes, and white lead made by

the old Dutch or stack process continues to be the best article of its kind. There is, however, one exception, which is, the Brimsdown lead, which was invented by Professor Bischof, and was fully described by Professor Sir William Ramsey at the Sixth International Congress of Applied Chemistry. This white lead is made by converting the metal lead into litharge (oxide of lead) by the usual plan of heating in an oxidising atmosphere. The litharge is then ground in a dust-proof mill and is next converted into a sub-oxide of lead, by heating it to a high temperature in a current of water-gas from which all deleterious sulphur compounds have been removed. The ground litharge is carried continuously by dust-proof elevators and conveyors to the top of the "reducers" and the sub-oxide escapes below. When a sufficient quantity of sub-oxide has collected, it is transferred to a mixing mill where it is moistened with water and continuously stirred until oxidation and hydration have taken place. This hydrated oxide is charged into a vessel containing a weak solution of lead acetate, and is there converted into basic lead carbonate, or white lead, by agitation with carbonic acid gas. The Brimsdown lead possesses a better body than even "stack" made white lead. It is also much finer and usually whiter. The whole process only takes forty-eight hours, while the whole Dutch process takes three to four months. An advantage in the manufacture is that, the process being a wet one, the risk of poisoning of those engaged in it, is reduced to a minimum.

Ready-mixed Paints.

Having considered some of the principal pigments which have come to the front in recent years, I desire now to say something concerning the ready-mixed paints which are gaining rapidly in favour. Until a few years ago nearly all the paints on the market sold mixed and ready for use were either of a very poor quality, intended only for the use of amateurs, or were certain special paints brought out for special use. Twenty-five years ago in America very few mixed paints were sold. To-day it is estimated that the annual production there is no less than 70,000,000 gallons per annum.

Of course, a good deal is to be said in favour of mixed paints and a good deal against them. I am speaking now of those mixed paints which are made from the best materials and are intended for the use of decorators and painters who do really good work. The advantages of such paints are, stated briefly, the saving of labour in mixing and the decreased cost. When one considers how a painter mixes his batch of paint under all ordinary circumstances, it must be acknowledged that the method is very primitive. The lead ground to a stiff paste in oil is broken up by means of a paddle or stick and the colour and thinners gradually added. This is a long and laborious process and, at the best, a somewhat imperfect one. The component parts of ready-mixed paint are, of course, very thoroughly and economically incorporated by means of machinery. Now experience has proved very conclusively that the intimate mixing and fineness of grinding bears a very important part in determining the actual wearing qualities of any paint. There is another advantage. When a paint is made from a mixture of different pigments, it is essential that the actual admixture be very thorough, but this can only be brought about by mixing in a machine. To give a single example:—An excellent paint is made from a mixture of zinc oxide and white lead, but if these two pigments are put in a paint can and an attempt made by the painter to mix them with his paddle, a very poor paint would be the result. In the same way, if small proportions of specially prepared silica or barytes are added they may prove beneficial provided that the admixture and the grinding is very thorough. There does not exist a perfect pigment, and the shortcomings in a certain quality of one may be overcome by the addition of a proper proportion of another which excels in that particular quality. It will probably surprise some of my audience to hear me assert, as I do very positively, that I believe that a proportion, say 10 per cent., of barytes added to white lead paint is a positive advantage as far as durability is concerned. The reason is that the barytes, being inert, is wholly unaffected by sulphurous air, which affects the lead; and although barytes has practically no body at all, yet so small a proportion does not materially weaken the good quality of lead in that respect.

The objections which are urged against ready-mixed paints are first, that as the condition of different surfaces to which the paint is to be applied varies considerably, it is necessary for the practical painter to mix his paint according to the circumstances, using more or less pigment and thinners as may be necessary,

and that a uniform paint, ready mixed, would, therefore, often be useless. Another objection is that in order to produce a good decorative effect a colour should be mixed in the actual room in which it is to be used. As against these arguments there is the fact that perhaps only a proportion, say 20 per cent. of all the paint work usually done is abnormal or requires special mixing, and in those cases special paints could be mixed to suit the circumstances. In the other 80 cases the ready-mixed paints could be used with a saving of money. It is no doubt true that colours intended for decorative purposes should be mixed in the room in which they are to be used so as to make allowances for the light and local conditions. As a matter of fact in a very few cases are colours so mixed; they are almost always prepared in the paint shop and brought to the job ready for use. When a piece of work of a high decorative character is being prepared ready-mixed paints would doubless not be suitable. In most cases, however, a colour can be chosen which would be suitable or there would be no diffiulty in a decorator adding a little of another colour to the mixed paint to change the hue according to his taste.

This question of colours is one of the most difficult in connection with ready-mixed paints, because so many shades and tints are required, and it is very irksome for a paint dealer to keep on hand perhaps as many as a hundred different colours. The difficulty has to some extent been overcome in an ingenious manner by one prominent manufacturer who has brought out his paints in twenty different standard colours—blues, greens, reds, browns, maroons, &c. The firm issue a colour card, which gives small specimens of paint, showing the standard colours at the top, and underneath the tints which are produced by adding different proportions of white. In this way, a paint dealer has only to stock the twenty colours, while the painter can obtain a large variety of tints of known value by adding the proportion of white specified.

Another objection which has been raised to this class of paints is that as they are prepared ready for use they must contain driers, and that as there is always a space left in the sealed can containing air, the paints, if stored for any length of time will, as the painters say "go fatty," that is, the process of oxidation will commence. There is, no doubt, much truth in this, and it might even be possible to label the cans with the date they are sent out from the factory, so that they might be used within a reasonable length of time, and if not sold within that period, they can be returned to the manufacturers who would, no doubt, very readily regrind them, and by adding extra thinners, make them again into good paint. As against this, it has been suggested that inasmuch as new white lead is never satisfactory in use, the longer, within reason, that ready-made paints are stored, the better they will be, but I am inclined to think that the manufacturers who are alive to their own interests in maintaining the reputation of their brand, would not use anything but well matured lead and the best of materials. This question of brands is, of course, very important, and as long as the quality is continually kept up to standard, the manufacturers have, I think, every reason to hope for a long continued increase of trade, because architects and engineers who specify such paints and find them turn out well will be very likely to continue to specify them year after year.

I may, perhaps, be permitted to consider myself as representing to some extent the decorator's side of this question. But even so, I cannot see that their extended use is not to his advantage. If the cost of the paint is reduced he is more likely to obtain increased work, for, of course, repainting is usually looked upon as a luxury only to be done in cases of necessity, or when one has a little surplus capital to spend.

At the same time it must not be supposed for a moment that I anticipate that ready-mixed paints will take the place of those paints which are mixed by experienced decorators to fit them for the particular piece of work in hand, otherwise the painter's occupation would be to a large extent gone. Still, I do think that ready-mixed paints have much to recommend them, and, provided that they are used soon after being made, they can safely be employed on all ordinary work.

I have already asserted that the opinion of those who have closely studied the subject is that a better paint can be made from an admixture of different pigments in the proper proportions than can be obtained by using a single pigment, and I have intimated that this admixture can only be done thoroughly by the aid of specially constructed machinery which grinds them together to very fine particles. And this leads me now to say a few words concerning fineness.

Fineness of Pigments.—Recent investigations have shown that the fineness of pigments

has much to do with the durability of a paint, and it is certain that the same pigment may be rendered much more lasting by an additional grinding to increase its fineness. Some of the lead which comes from the Continent, although perfectly pure or, as is known in the trade, "genuine," is of a very coarse description, and this makes it a bad paint material because it may be taken as an invariable rule that a coarse pigment can never make a good paint.

Mr. Robert Job examined a large number of pigments with a microscope and gives it as his opinion that fineness and sub-division of pigments is of the greatest importance.

The following is a Table of the fineness of pigments based on one recently issued by the scientific section of the Paint Manufacturers' Association in the United States:—

White Lead	·000074
Zinc Oxide	·00002
Sublimed Lead	·00003
Blanc Fixe	·00012
Lithopone	·000028
Barium Carb	·00016
Silex	·00024
Calcium Carb	·00012
Am. Barytes	·00008
Ger. Barytes	·00008
Gypsum	·00032
Asbestine	·00016
China Clay	·00016

One of the reasons then why mixed paints are likely to succeed is because they are finely ground. The question of "going fatty" is worth consideration. And I may here repeat a suggestion which I made before the Paint and Varnish Society a few months back. It was that it might prove feasible for paint manufacturers to issue their mixed paints not quite ready, for application, but in various colours and shades, sent out in paste form. The paint could consist of a mixture of lead, zinc, or other pigments, as might be thought desirable, and the idea would be that the painter would break up the paste and add his thinners and driers according to the conditions of the work. Or special thinners and driers might be supplied ready for use with each brand of this paste paint. It would do away with the possibility of oxidation, and on the whole prove perhaps much more convenient than the ready-mixed paints, because it would leave more to the judgment of the painter than the mixed paints do. And there is another suggestion which I should like to make here to paint manufacturers. It relates to the production of three separate kinds of paint to be put on the same surface, viz., one mixing for the priming, another for the second and subsequent coats, and the third for the finishing coat. Paint as usually applied consists, of course, of a priming, usually made of white lead, to which is added a little red lead to give an increased hardness, and to facilitate drying, and then the same white lead paint is used for all the other coats, a little difference being made in the sharpness, that is, the quantity of oil used, but it does appear to me to be very evident that it is unscientific to use actually the same pigment or same paint throughout the different coats. To mention a single example, why not—having primed the work in the usual way—give the first coat upon it wholly of lead so as to take advantage of the body of that pigment, and then why not finish the work with pure oxide of zinc so that the surface actually presented to the atmosphere should be as stable as possible. At least one manufacturer has proceeded on the lines I have indicated and produces paints in three grades intended for application to the same work. I can but think that there is a good deal in this plan which merits close consideration.

Unquestionably there is a wide field for investigation in the properties of pigments mixed together in various proportions, an investigation which can be very largely proceeded with by actual experiments, and I come now to a suggestion which appears to me to be worthy of careful consideration by this Royal Society of Arts. It is, that a committee be appointed to have prepared boards and sheets of iron, to cause them to be painted with various mixtures of pigments ground in oil, and to have these exposed in different parts of the country for say two years. At the end of that time all the specimens could be brought together, and examined by a second committee, consisting of painters and paint experts, who would arrange them in order of merit, according to their condition. The pigments, I suggest, which might be experimented with, are pure white lead, pure zinc oxide, and admixtures of the two in equal proportions, and say 25 and 75 per cent., and 75 and 25 per cent. respectively of each. Further, various proportions of barytes could be mixed with lead and zinc to ascertain the effect they had on the durability. Graphite paint, oxide of iron paints, red lead for iron work, might also be experimented with. It might be thought practicable to allow any manufacturers of a registered

brand of paint, particularly those intended for iron, to submit samples, and to allow these to be tested by exposure in the same way, and such manufacturers should be called upon to pay a small fee to cover working expenses. The reason I suggest that samples be exposed in different parts of the country will doubtless be obvious. A paint which might stand very well in the pure air of the country might quickly decay when used in a chemical town like Widnes or a smoky city like London. If one could get exposed some boards in the inside of railway stations it would also go a great way toward determining the durability of such paints. A small committee could arrange the preparation of the samples and without doubt some exceedingly valuable information to engineers, architects, decorators and paint manufacturers and paint consumers generally would be brought out by such investigations.

Something of the kind suggested is now being done in North Dakota where an experiment station has been started, several experimental paint fences have been erected, these being painted with various combinations of pigments. The tests will be continued for a series of years and frequently repeated.

Gilding.

I now turn to a consideration of some of those improvements in decorators' materials and methods which are more closely connected with decoration. First, I come to the application of leaf gold to various surfaces for a decorative purpose. For very many years the practice has been to reduce the gold leaf to squares of $3\frac{1}{4}$ inches and to enclose these in books containing 25 leaves of paper, which is treated with powdered bole to prevent the gold from sticking. The actual application of the gold leaf is effected by painting the surface to receive the gold with a peculiar variety of varnish, known as "goldsize," and when this is in the condition known among painters as "tacky," that is, dry enough to prevent dust adhering but sticky enough to cause anything pressed on it to adhere strongly, the leaves are taken up by a thin flat camel's hair brush known as a "tip" and applied to the tacky surface one by one. The improvement to which I now refer effects a very great saving of time, and it is done by producing the gold leaf in long ribbons, varying in width according to the surface to be covered. As a rule, gilding is done in lines, and the ribbons of gold are made in widths varying from 3/16 in. to $3\frac{1}{4}$ in.

The ribbon gold is interleaved with paper and rolled to form a wheel, this wheel being enclosed in an instrument, simple in construction, which permits the gold being applied in long lengths to the tacky surface with almost a stroke of the arm. In order to reach inequalities of surface, as for example, in gilding an ordinary egg and tongue moulding, a second pattern of the little appliance is made, which is provided with a small stiff-haired brush of a width corresponding with the width of the ribbon gold, and by means of this the gold leaf may be expeditiously caused to adhere to the tacky surface. I understand that the actual cost of the gold leaf thus prepared is somewhat higher than that of the ordinary form in books, but the saving of time is so great that a conservative estimate is to put the saving of cost of any ordinary piece of gilding at perhaps one-half of that executed by the old method.

The invention has been on the English market for some years and is gradually increasing in use among house decorators, but is now almost exclusively used in such work as the gold lines on tramway cars, railway carriages and other vehicles. We shall now see the appliance in actual working.

I may now draw attention to a material called Alabastine, which is supplied in the form of a dry powder, and when mixed with water gives a paint which sets very hard. In addition to its use as an ordinary distemper, some very novel effects may be produced by preparing a coloured coat, placing upon this a white coat, and while wet manipulating it in such a manner as to remove some portion of the coat showing the coloured surface beneath. In other words it is treated in the same way as graining, but with the difference that no attempt, of course, is made to imitate a wood. When a very thick coat of this material is applied and a board is pressed against it, and is then gently pulled away, the material is drawn out in the form of small irregular "hills," so to speak, which gives a very pretty appearance and which may be produced very inexpensively. The irregular surface lends itself readily to being ornamented with gold leaf or gold paint in various colours, and the samples exhibited give some idea of how this may be done. In finishing a frieze a good effect may be produced at a very little cost by treating the surface in the manner indicated and then forming medallions at suitable intervals. These medallions are usually formed by the simple means of pressing the back of a

dinner plate on the material while wet and then working up the surface contained within the circle to an appropriate design.

Another material which should also be mentioned is Alabastine-Opalia, a stiff pastelike material which is similar to Gesso and which sets literally as hard as rock when dry. The material is placed in a soft rubber tube fixed with a brass nozzle. Various shaped nozzles are provided and the Opalia is squeezed on to the surface of the wall or ceiling and by a little skilful manipulation many excellent effects may be produced. When a nozzle having a plain slot orifice is used, the material as squeezed out comes in the form of a ribbon which may be twisted and otherwise regulated with excellent effects. Such details as husks so largely used in the "Adam" designs may be very quickly produced by this means and designs executed in in this way have the charm of being evidently prepared for the particular position they occupy.

Among the improved appliances which have been placed in the hands of the decorator, is the "Aerograph," an instrument for distributing colour by means of a current of compressed air, which was fully described by its inventor, Mr. Charles L. Burdick, before this Society in December, 1905. Since that time, decorators have employed the Aerograph for stencilling, in the place of a brush, in figure work and for mural decorations generally. It has been found that when the instrument is used, a great saving of time is effected, and although the colour is blown on to the surface, instead of being applied by a brush, great delicacy and softness of detail may be obtained. Graduated effects are very easily obtained as, for example, when it is desired to tint a frieze in a dark colour at the bottom, where it joins the wall covering, and to lessen the colour gradually toward the top, as the ceiling is approached. This result is speedily obtained by holding the nozzle of the instrument close to the surface at the bottom, and at a gradually increasing distance as one works towards the top.

The various examples of decorated fabrics, portraits, &c. shown, indicate the beauty of the work which may be done with this instrument which, I may mention, is now profitably employed in connection with the production of hand-worked wall paper friezes, which are now produced in large quantities and sent out ready for fixing like ordinary papers.

I may now pass to a consideration of the so-called "Painting machines" by means of which oil paint, distemper or whitewash, may be applied to a surface by being blown thereon by compressed air in the same way as is the case with the Aerograph, excepting that the nozzle of the instrument is different. As a fact a larger type of the machine mentioned is now made, but there are various other makes on the market. The question has often been put to me, "Can these machines be used profitably instead of a brush for the application of oil and other paint?" The answer is emphatically in the affirmative in many cases where a great smoothness is not necessary, but I do not think they will ever take the place of brush work in house painting. In some cases, however, better work can be done by the machines than could be effected by the brush, as for example, a very rough brick wall which is to be limewashed. In such a case the spray of limewash thoroughly reaches all the interstices, and this would be very difficult to do with a brush. The saving of labour when a paint spraying machine is used is very considerable, 50 to 60 per cent. saving is not an exaggerated estimate. In painting ironwork and large surfaces generally, these machines can profitably be employed, provided that, as already stated, it is not important that the surface be quite smooth, as would be the case when brushes were used. Briefly stated then, painting machines are excellent when a large surface is to be covered and when the paint to be applied is not very thick. If it is thick the nozzle of the spraying machine is likely to become choked up.

As I have said my paper must of necessity be somewhat discursive, and I should like now to make a passing reference to another interesting type of mural decoration which has come into use during the last few years, viz., the class of jute fabrics which are used as wall coverings, sometimes plain, but not infrequently printed or stencilled with simple conventional designs. These fabrics are supplied in many different colours of charming hue and some of them are shown to-night. They are very durable and form an excellent background for pictures and they have, therefore, been employed to a considerable extent in the decoration of various art galleries. The fabrics are, as a rule, somewhat coarse in texture, which from an artistic point of view is a distinct advantage as it breaks up and softens the surface when viewed from a distance in a very satisfactory manner. The fabrics are backed in a special manner with an adhesive material so that when paste is applied they may be

hung practically in the same manner as ordinary wallpapers. It is worthy of mention that nearly all of these fabrics are made in Scotland, although some are exported thence to America and reimported into Great Britain after having been dyed in a special manner. The objections to such decorations are, first, that they are apt to fade, and the second that the minute hair-like fibres which stand out from the main surface of the fabric are, in conjunction with the irregular surface of the fabric itself, very likely to "catch the dust," a phrase which will be well understood. I think that the charge of fading may now be wholly withdrawn, because during the last two or three years great improvements have been made in this respect, and most of the materials in question will withstand the action of strong light. That they retain dust which settles on the surface cannot be gainsaid, but the periodical use of a feather duster over the surface removes this difficulty. By a process of rolling, the fine hair-like fibres are laid permanently down. When something of a more decorative character is required than that obtained by using the plain material, a handsome hand-stencilled frieze in perhaps somewhat brilliant colours gives a very charming result. The stencilling is done in the ordinary way upon the coarse surface of the fabric, and the very coarseness is, as already mentioned and as will be readily understood, a distinct advantage.

Another material which I should like to draw attention to is called "Matsine," which may be described as a series of oil varnish transparent colours which may be used to produce novel and artistic effects. "Matsine" is made in 13 different colours and dries semi-flat. It may be used with excellent effect for ordinary graining as the samples before you will show, but it may also be employed with satisfactory results by using a dark colour over a light ground and drawing a brush over the "Matsine" while wet, which will remove a portion of it and leave the bright surface underneath showing through. The process is very economical and very acceptable from a decorative point of view; for example, this blue "Matsine" on pitch pine is very beautiful, while the green "Matsine" on canary wood is also very effective.

Enamels.

Within the range of those improvements in decorators' materials, which may justly be described as both artistic and useful, are enamels. They are, perhaps, the most important development in decorators' materials and methods in recent times. Enamels, japans or enamel paints as they are variously called are, at the present time, used to a very large extent for interior painting and increasingly for exterior work. An enamel paint may be said to consist of a pigment, usually zinc oxide, ground in a special varnish, or in a specially treated oil, which causes it to dry with a brilliant gloss. Enamel work, of course, has been used for very many years, and many present, to-night, will doubtless remember the beautiful white enamelled woodwork of former years, examples of which are still sometimes to be found in old mansions. This work, however, as formerly executed, was very expensive, necessitating as many as seven to ten coats, with careful rubbing down between each, the final coat being a pale and very expensive varnish. The enterprising paint manufacturer has, however, put within the reach of everyone means for obtaining practically the same effect at an expenditure of time and material, of perhaps one quarter of the expense formerly necessary, in fact, good enamel work can be done now-a-days, in three coat work, for 1s. a yard super. for all labour and materials, and as it will last, in good condition for years or more, it is very economical.

White enamels are the most popular, but they may be also had in colours, or may be tinted as required. It is essential to success that a perfectly level surface be obtained upon which to apply the enamel, and the usual plan is to give first a coat of white lead or a special filler made by the manufacturer of the enamel, and then a coat of white paint made of half lead and half zinc oxide or some other special mixture, and finally, a coat of pure zinc oxide finishing with one or two coats of enamel. It is well to consider the enamel itself almost in the nature of a varnish, to see that the surface underneath it is quite white and quite level, and to apply the enamel just in the same way as a varnish, that is to say, "flow it on" instead of brushing it out, terms which practical men will fully understand.

The advantages of enamels may be said to consist, first, in their remarkable durability, and secondly, in their beauty. As to the durability, white enamel woodwork, if properly done with good materials, will last almost indefinitely, certainly ten years is not an extreme limit. I may mention that in my own home I have an enamelled room, which has been done nearly five years, but which is

in as good condition as when first executed. A good enamel dries slowly, but ultimately attains extreme hardness and provided that the work is not knocked about in a way to cause chipping, will last for a long time. It is my deliberate opinion that white enamel may be used in any and every room of a dwelling house with advantage. Even a kitchen might be painted with enamel and possess a very clean and wholesome appearance, and the enamel if of really good quality and properly applied will last so long as to become cheaper in the end than ordinary paint. Enamels, too, are being largely used, not only on woodwork but on plastered walls, because they may be washed down frequently without causing any injury to the paint. Dirty finger marks may also be easily removed with a damp cloth, and everything considered, it appears likely that large as the present consumption of enamels is, that it will increase in the future. For outside use enamels have also proved to be very durable, but here I have very little data to go upon. If I may be permitted to give an opinion it is that there is a very bright future in both senses of the word for specially prepared enamel paints which have as part of their constituents thoroughly durable resinous gums, particularly so if the users will remember the essential necessity as far as durability is concerned of cleaning down the surface periodically.

Flat enamels are another triumph of the paint and varnish makers' art. Briefly, these paints may be said to combine all the beauty and softness of a distemper with the durability of a first-class oil paint. As the name signifies they dry perfectly flat or without gloss. The best brands are easily applied, and flow without leaving signs of brush marks.

Flat enamels may be used very effectively in conjunction with glossy enamels, as for example, the panels of a door can be put in flat and the stiles and rails glossy. When a surface is somewhat uneven it is often more economical to finish it in flat enamel than it is to go to the expense of bringing up the level in the ordinary way. The flat enamel hides the inequalities while the glossy enamel accentuates them.

The beauty of glossy white enamels is sometimes questioned, and the popularity of them has led to the phrase "white disease." As a matter of fact, when the woodwork is finished white the room is much lighter. Generally speaking, an apartment is more comfortable and cosy when a comparatively dark paper is used upon the walls, but if the woodwork is dark this renders the room somewhat sombre in appearnce. A fairly dark paper, then, used in conjunction with and by way of contrast to a white enamel woodwork gives a pleasing and satisfactory result. Many halls of hotels and other public and private buildings which would otherwise by quite dark are appropriately finished in white enamel, while the use of the same material on the great ocean liners is sufficient evidence of the beauty of them as well as of their extraordinary durability even when exposed to the severe test of the paint-destroying action of the sea air.

Washable Distempers.

Turning again to another improvement in decorators' materials we come to washable distempers. Of course, distemper painting has long been popular because of its beauty and softness. The disadvantage of the use of ordinary distemper, however, is that the surface cannot be washed, while the moisture, condensing on the top of a wall in sufficient quantity to mark the distemper, will carry the dirt with it in its downward course and cause a mark which cannot be obliterated.

Washable distempers or "water paints," as they are frequently called, have gained in popularity very largely during recent years. They have been on the market, however, for some thirty years, but it is only during the last ten years that their advantages have been very widely understood. As a wall decoration they give a perfectly plain surface which is often —one might almost say generally—most satisfactory as a background to pictures and furniture, and as they are made in more than one hundred different colours, there is no difficulty in getting any shade or hue required. It is not too much to say that the enterprise on the part of the manufacturers of washable distempers has improved to no small extent the standard of mural decorative art in this country; and I say this because it must be admitted that it has opened the eyes of the public to the value of plain surfaces in interior decoration. In passing, it is interesting to note that the appreciation of plain surfaces thus brought about has led to the production of very many different shades and tints of perfectly plain wall papers, ingrains, &c., that twenty years ago would hardly have been tolerated. Thus we have very fortunately broken away from the old idea that effective decoration meant the crowding of ornament into every available inch of wall surface, and we have arrived at a point

where it is understood, in part at least, that walls for decorative purposes must be considered as a background to our pictures and our furniture and must be dealt with accordingly.

Still another class of paints which come within the term "decoration" are Aluminium paints. These form another class of decorative and useful materials which have come into extensive use during the last five or six years, although their use is largely confined to beautifying and preserving iron work. These paints give a very handsome appearance, similar to dull silver, and may be used with excellent effect on cast and wrought iron generally. The chief advantage of these paints is in the colour, which is much handsomer than grey, and moreover they do not turn yellow or show the dirt like white paints do. I should like to give here another little personal experience. About five years ago, I had painted an iron work balustrade in my own house. Only one coat was used and I found the paint to possess a great deal of body so that one coat properly applied was ample for the purpose of a complete covering. At the end of two years the brilliant silver-like appearance of the iron had become considerably diminished, but I found that this was due to the smoky atmosphere which had distributed a film of dirt on the surface and that this could be readily removed with a damp cloth. Even now, after so long a period as five years, the paint is in a very fair condition, which goes to show that aluminium paints have a distinct protective value as well as the advantage which is derived from their appearance.

On the other hand, I may mention a case to the contrary. When travelling to Newcastle by boat, I saw one of the deck hands applying aluminium paints to some of the work on the vessel, and I enquired how frequently it was necessary to renew the paint. I was surprised on being told that it was necessary to repaint about every month or six weeks. This suggested adulteration, but on making careful enquiries I found that, as a matter of fact, the aluminium is usually employed pure, and without adulteration, being reduced to a powder for the purpose. It is, however, on the "conveyor" and vehicle, which is mixed with the pigment, that the durability largely depends. Two distinct classes of aluminium paints are now made, one suitable for inside work only, and the other for iron work which is exposed to the weather. The paint intended for use on the inside withstands a very high heat, and is, therefore, suitable for use on steam radiators, &c. Some of the best aluminium paints are made on the principle of gold bronze paints, that is, with collodion varnish, but with this advantage, that the so-called bronze paints almost invariably tarnish, while the aluminium is practically unaffected by the atmosphere. The advantage of using collodion varnish is that, owing to the whiteness of the colour and the nature of the varnish, it is calculated to show off the metallic shade of the aluminium powder to the best advantage, and it has the additional advantage of drying practically instantaneously. There are no doubt other light coloured varnishes which would answer for making a handsome aluminium paint, but they would probably be more expensive and less efficient than collodion varnish.

The disadvantage of collodion varnish is that it will not stand when exposed to the weather, notwithstanding the claims of various makers of this type of paint to the contrary, although it will stand when used indoors for practically any length of time, but is an utter failure when used outside, and it is probable that the paint which gave such bad results on the Newcastle boat was of this character. Aluminium paints which are used outside are best made with an oleo-resinous varnish similar to those employed in making enamels, and although these do not show the beauty of the pigment off to its full extent, they, nevertheless, when light in shade, do so sufficiently well to make it a very handsome article for application on structural work, piers, bridges, railings, gates, railway stations, &c. Aluminium paints made in this way stand outside for a great length of time and have the advantage over other preservative or anti-corrosive paints that the pigment is less affected by adverse conditions than the pigments of other paints are, owing to the fact that aluminium is not affected by most acids and chemical fumes which would be injurious to other paints. An experiment tried with a plate covered with aluminium paint and exposed to strong sulphur fumes for several days showed that the paint was wholly unaffected, hence, aluminium paints are exceedingly useful for painting machinery, &c., in chemical laboratories and for other places where acid fumes would adversely affect ordinary paint.

I have already mentioned that some grades of aluminium paint will withstand a very high temperature. Some manufacturers claim that these paints are proof against heat, but such

claims cannot be substantiated, for naturally any organic matter subjected to red heat would be destroyed. The reason that aluminium paint when applied to iron withstands heat is that the aluminium pigment being flakes melts a little and attaches itself to the iron. The vehicle or conveyor is, of course, at once destroyed as soon as any appreciable heat is applied. A surface painted with aluminium paint and subjected to red heat becomes, therefore, practically like an aluminium plated surface.

Having so strongly recommended aluminium paints, I think it necessary to mention that there are not a few on the market which are utterly worthless because of the free organic acids they contain, and these acids, of course, assist rather than prevent corrosion of the iron to which they are applied. So that if any of my audience have tried aluminium paints and found them a failure they may take it they were unfortunate in their choice, but there need be no difficulty in getting a half-dozen or more brands of first-class aluminium paints which have all the advantages above outlined, and these advantages consist in a pigment which is unaffected by most acids, and this cannot be said of any other paint unless they should be made from real gold or real platinum.

Paint Removers.

Another recent improvement in decorators' materials is in the manufacture of paint solvents or removers which have been very greatly improved during the last few years. When it becomes necessary to remove coats of paints either from wood, iron, or other work, the plan formerly adopted was to hold a small portable stove filled with glowing charcoal against a portion of the work which softened the paint and permitted it to be scraped off. This, however, was a slow progress and gave way to the use of the painters' torch or blow lamp, which are still used to a very large extent. The latest improved form of these lamps permit of either the use of benzoline or petroleum, and a small pump attached gives means for producing a pressure on the liquid which is forced out as it is burned and gives an intense heat. The drawback to all burning off, however, is that objectionable fumes and smoke are produced which for inside work is very disagreeable, while if the work is of a delicate character, say, fine mouldings or carvings, the heat of the lamp is very likely to char and destroy them. Under these circumstances paint solvents have been used for many years as a substitute. These formerly consisted of the greater part of a mixture of a strong alkali and lime, and although effective in itself, this had two serious objections. First, it was very injurious to the hands of the workmen applying it, next, it was necessary to neutralise the alkali remaining on the wood after the paint had been removed by the application of dilute acid, usually vinegar. This was both troublesome and risky, because if the proportion of acid were too great or too small to neutralise the alkali remaining, the paint subsequently applied would be injuriously affected.

But the last year or so has shown the production of some excellent paint removers free from all these objections. They consist of the most part of fusel oil or acetone, and are applied by means of a stiff brush to the paint, which is softened in three to five minutes for each coat of paint. The best of these paint removers have the addition of wax, which prevents the rapid evaporation which occurs when wax is not used. The paint may be scraped off very readily after it has had time to get quite soft, and the surface remaining is simply wiped down with a piece of rag or waste cotton dipped in either benzine or turpentine, when the work is at once ready for repainting. There is no difficulty in removing paint from carvings and delicate mouldings by using this class of paint removers provided that care is taken not to injure the woodwork, and with this object specially constructed tools of hard wood with sharp edges and points can readily be made at a small expense.

Turpentine Substitutes.

Genuine American turpentine has, for some time past, been gradually becoming scarcer and hence more expensive. I have it on good authority, that it is hardly possible that the price can ever materially be lower, because the supply is quickly becoming exhausted. Much of the so-called American turpentine on the market is made by distillation from sawdust, roots of pine trees, &c., and is deficient in some of the essential properties of the genuine turpentine. Under the circumstances, painters and varnish manufacturers have been looking for something which would take the place of American turpentine. Russian turpentine has been used with success, but most of that sent to this market possesses an objectionable odour. A few firms, however, have by distillation removed this, and the Russian turpentine is, perhaps, as good as that of American

origin. The various substitutes consist of what is known as white spirit, a petroleum product which may be compared with benzine, but made in such a manner that it evaporates much more slowly. The object of adding turpentine to a paint, is simply to thin it or reduce it in consistency to render it fit for application by means of a brush. It serves no other purpose, and wholly evaporates. It is essential, however, that this evaporation be not too rapid, especially in flat work, that is, work which is to be finished without gloss. White spirit is now produced, which practically evaporates at the same rate as American turpentine, and may be safely used in place of it. Among the substitutes on the market, there are some which contain a proportion of genuine American turpentine, which is only added to give the characteristic smell. I am inclined to advise against the use of these because they come too near an adulterated article. If white spirit or its equivalent can be successfully used in place of turpentine, I think it should be sold for what it is and not in a condition which might mislead a purchaser into supposing it was a different article altogether.

Paint Dipping.

Before I conclude, I may say a few words about a new departure in painting made during the past few years, which bids fair to gain popularity, is that of employing the "dipping process." It does not strictly apply to decorators' work, but consists in a method of dipping the article to be painted bodily in a special mixture of paint, so as to save the cost of application by the ordinary means. The method has been successfully used in the United States for many years past, and is in operation in this country in several large manufactories of agricultural implements, wagons, &c., and at the Royal Arsenal at Woolwich. It was at the latter place that I was permitted to inspect the plant and process which I may now briefly describe. Artillery and other wagons are chiefly dealt with, and the paint dipping plant is contained in a very long building, having a large tank filled with paint at each end, and the top of the tanks being on the level of the floor. A series of overhead rails are laid from end to end of the building, from which the wagons as painted are suspended. A new wagon ready prepared, stopped and primed, is lifted by a crane by means of a chain surrounding it, plunged bodily into the tank, which is nearly full of paint, and is then immediately lifted out again. the paint adhering to every part, including, of course, the openings between the joints, and this is clearly an advantage from a protective point of view. The wagon is then suspended from the rail and pushed towards the other end of the building. A few minutes afterwards another wagon is similarly treated and hung alongside of the first, so that long rows of wagons are gradually pushed toward the tank at the other end of the building, by which time the paint is sufficiently dry to be in a condition to receive the next coat, that is to say, the paint is not hard but slightly "tacky," and this condition is desirable in order that the two coats may be thoroughly united. To facilitate the passage of the wagons from one end of the building to the other the rails are slightly inclined. As each wagon reaches the second tank it is taken from the rail by the travelling crane, plunged into the tank and again suspended on a second series of rails leading to the first tank, if a third coat is to be given, or is taken up to the store-room on the floor above.

In conclusion, I would again urge upon the Royal Society of Arts the advisability of appointing a committee to take steps with a view of experimenting by means of exposure with various pigments and mixtures of them. The Society has, of course, done an immense amount of good work for various industries, and it would, by causing to be carried out the experiments I have suggested, give very valuable information to architects, engineers, decorators, railway companies, municipal bodies, and all others who are large consumers of paint.

DISCUSSION

The Chairman (Sir William Emerson), in opening the discussion, said he had been much struck with the point the author had made of the use of zinc oxide instead of white lead. He understood that on the continent and also in this country a number of architects declined to use lead paint at all in the interiors of buildings in consequence of its unhealthinesss, but as it stood perfectly well outside it was exceedingly useful for that purpose. The remarks made with regard to graphite for painting iron were entirely new to him, and were exceedingly useful knowledge. For flat surfaces, he did not care for the method of cheap, economical, and speedy gilding which the author had mentioned, as he believed the old method of laying on little squares of gold leaf so that the joints could be seen was infinitely more artistic and preferable. The

Alabastine method of obtaining a rough texture on the surface of things might be used in certain cases with advantage. He also thought that washable distemper might be used very much more frequently than it was, as it gave soft colours. It was very much better than oil paint when done properly, because it did not give the reflections that oil paint did. If the laborious method of burning off paint could be done away with by the paint remover the author had described, he also thought that would be an advantage. In one respect he had been a little disappointed because he felt that a paper on "Improvements in Decorators' Materials," ought really to cover a larger ground than only paints, gilding, and enamel. Decorators' materials included a great many more things than paint, although he knew that if the author had mentioned them all, the paper would have been of a prohibitive length. For instance, he might have referred to the improvement made of late years in the beauty and condition of tiles; the exploitation of marble quarries, which now produced all sorts of ornamental marbles, of every hue; textile fabrics, such as brocades, tapestries, silk, and other woven materials; and embossed and stamped leather. The improvements in wall papers during the last twenty-five years had also been wonderful. The author might also have referred to mosaics for floors and walls, and the improvement in plaster decoration, ornamental woods, iron and bronze work. However work was designed or arranged, unless the material was absolutely the best the work was useless; and the Society was therefore greatly indebted to the author for the scientific light he had thrown upon the various pigments for paint work.

Mr. J. D. Crace agreed with the Chairman that the title of the paper was not correct, and suggested that it should have been "House Painters' Materials." Personally, he should be inclined to call for an improvement in the decorators themselves rather than in their materials. There was no doubt that the improvements which had gradually come about in zinc paint had rendered it a most valuable foundation for painting. It would be a great saving in health, not only to the manufacturers but to the painters, which was a most important point in view of the new clause which had been added to the Workmen's Compensation Act. If a man would only keep clean, he need have no fear of lead poisoning. The use of petroleum as a substitute for turpentine had been mentioned. During the time of the American Civil War the exportation of turpentine was entirely stopped, and petroleum was used in its place in this country. There was no difficulty in its use, except its highly inflammable nature. The fumes of petroleum were different from those of turpentine, and had a somewhat suffocating effect, compared with the stimulating and healthy effect of turpentine. The use of graphite paint on iron was very valuable. The constant habit of painting iron with lead was a most destructive and foolish one. It answered the purpose for a few years, but directly the surface of the iron was in the least disturbed, chemical action with the lead began as soon as water reached it. Ready-mixed paints were undoubtedly economical for railway stations and places of that kind, but they were an absolute fallacy when discussing the question of decorators' materials. No man could say what shade or tone of colour it was necessary to use for decorative purposes until he went inside the room which was to be decorated, and all such colours ought to be mixed in the room, and nowhere else. Gilding by means of a roller was new to him, and he differed from the Chairman to the extent that he thought for small mouldings and plain run mouldings it would be a very useful and valuable adjunct for the decorators' use. He did not think it would be satisfactory, however, for large surfaces, for which purpose he did not think it was intended to be used. The Alabastine method undoubtedly gave a most delightful foundation and background for pictures, but its great drawback was that in a town it collected dirt, and its use would have to be practically confined to country houses. It was a great benefit to the decorator as well as to the painter to have a material which produced in plain colour such delightful effects; and the same might be said of washable distempers, which for large flat surfaces were infinitely preferable to paint. It was a very valuable thing to have a material which would remove paint without causing damage underneath. The great drawback to the use of water was that it saturated the wood, and the whole beauty of the surface was destroyed. Burning was a very good plan if it were not for the horrible smell it made, which rendered it impossible to use inside the house. He remembered at one time it was not an infrequent thing to remove paint from old woodwork with Portland cement. It had to remain on some hours, and to be removed before it began to set hard, but it was most effective in getting the paint off, and fairly free from saturating the wood, because the cement held the moisture and produced the action wihout saturation of the wood.

Mr. Walter Reid, F.I.C., after thanking the author for his eminently practical paper, said it had been stated with regard to the mixing of lead, in small quantities, with pigments other than lead, that if anything up to 10 per cent. of lead was added, it was an improvement on a paint which was not composed of lead, but of barytes, or of some similar inert matter. That was well from the sanitary and pecuniary point of view, but it was not well from the point of view of the duration of a paint. It was sure to become yellow, and experiments had shown him that the darkening of a paint due to the sulphuretted hydrogen of the atmosphere of a great city increased in greater proportion than that of the

lead, when the lead was diluted by another material. Therefore, if, for instance, 100 per cent. darkening of pure white lead was obtained, a great deal more than one-tenth of that darkening would be present if there was only 10 per cent. of lead in the paint. From the sanitary point of view, he thought one ought to be careful not to call a paint a lead-free paint if it contained anything at all in the way of lead. The fine subdivision of the pigment was everything from the covering point of view. Whatever pigment was subdivided in a very fine state, provided it was opaque it would cover well, no matter what it was. It should not be forgotten, however, that when an extremely fine pigment, which was inert, was used, a larger percentage of oil must be mixed with it; and in a paint where the pigment was inert altogether, the portion which gave way under weathering and oxidisation was the oil. Turpentine had a far greater action than being simply a solvent, it being like many of the essential oils a very strong oxidising agent. It always produced, in contact with the atmosphere, peroxide of hydrogen. The drying effect of turpentine was most marked. If a little white lead ground in oil was mixed with turpentine, and a similar amount with petroleum spirit, the difference in the drying would be at once seen. There was one statement in the paper which ought not to be allowed to pass without contradiction, namely, that the cracking was due to the turpentine. It was nothing of the kind; it was due to an entirely different reason. France was far ahead of this country on the question of the prevention of lead poisoning, legislation having been passed to the effect that paints containing lead must not be used inside houses, although they might be used outside. The result had been that a large quantity of paint was now made in France quite free from lead, which had a great covering power. He quite agreed with the remark which had been made that graphite paint was excellent, because it repelled the water. If a painter wished to get a light-coloured paint that repelled water, by giving an outer coat of a pigment containing French chalk, the water would be repelled, and the paint last much longer than if such a thing as chalk was used. If some of the soaps, such as alumina soap, were added to the paint, a wonderful water-repelling surface was obtained for three or four years, and if the water did not get in the film of paint lasted longer. Vermilions were now tinted with dyes derived from coal tar; but he thought it would be found that no dye derived from such organic substance was, in its pure state, so permanent as a properly made vermilion. The vacant space in a paint tin was, he thought, quite immaterial, the quantity of oxygen in the space being absolutely trifling. The mixing of paint in a pot during half an hour would absorb fifty times as much oxygen as paint could get in the small vacant space in the tin, but if it was thought it might do damage it was a simple thing to fill the vacant space with carbonic acid, nitrogen, or waste gases from a furnace. Many of the experiments which it had been suggested the Society should carry out had already been performed under the auspices of the Royal Academy and other institutions, but not on all the modern pigments. The combination of the pigments and of all vehicles used ran into thousands, in addition to which the surfaces upon which they might be used had to be considered, so that the experiments would be of enormous length. The main feature of the ingenious little apparatus for applying gold leaf was that the gold leaf could be applied in a line without wasting 50 per cent. of the gold. He had the advantage of seeing some extensive experiments made with it at the St. Louis Exhibition, where he was chairman of the jury, and it performed the work ten times as quickly as it could be done by the old method. The gold size used in gilding was the weak point, a fairly good material being put on one which was essentially evanescent. The gold size was an oxidised linseed oil, and as long as it was there the seeds of decay were underneath the gilding. The Germans had introduced a burnished aluminium as a species of gilding, especially for picture frames. Upon the burnished aluminium a yellow varnish was placed, which gave exactly the tint of gold, and it was impossible at a short distance to detect which was bright gold and which aluminium covered with a varnish. It would be of interest if the author was able to state what the composition of Alabastine was. The aerograph was a very great gain to the decorator. He did not think it was right to condemn collodion in itself, but the mixtures which were sold in that way, because they were soluble gun-cotton mixed with camphor and dissolved in spirit. That was a cheap but a bad form of getting a solution, because after a time the camphor evaporated, and nothing but nitro-cellulose was left, which was brittle and peeled off. Such a paint ought never to be used. Acetone would be very expensive as well as volatile for a paint remover, but acetone oil was not so volatile. Fusel oil could not be used because the smell was terrible, but solutions which were derived from fusel oil, which were solvents of the oxides of oil, could be used. He thought plenty of turpentine would eventually be obtained, because Russia, Canada, and other countries would produce a supply. At the present time the turpentine in America was being used for the production of synthetic camphor, and the supply had not reached the demand; but he had no doubt it would eventually do so, because there were enormous forests of fir trees in existence. In the same way, in regard to varnishes, a short time ago, there was a shortage in shellac, which at the time was being largely used for electrical purposes; but chemists set to work and produced a synthetic lac known as "brillac," which was very much better in some of its qualities than the natural article. What was urgently needed, at the present time, was a substitute for linseed oil, and when that was obtained,

the weak point, in connection with paints, would be overcome.

Mr. E. BRAND thought graphite paint was very useful for painting exposed iron work, but he did not think it would ever be generally used, because of its nasty colour. It had been tested on railway carriages in America and Canada, and had stood well, but for iron work in general, he was informed the painters preferred a paint made with pure zinc oxide, made up with the very best linseed oil and turpentine. There was no doubt that genuine zinc oxide was a very good thing for making paints. Many beautiful improvements in tiles and wallpapers had been brought about by the use of zinc, which was non-poisonous. The surface of zinc was enamelled and an exact reproduction of tile work obtained. It was also of interest to state that experiments proved that zinc would preserve iron from rusting, the American Admiralty having issued a report giving the result. The English Admiralty used a large quantity of zinc paint made up in a stiff paste, which was used in between the iron work of the ships because it preserved the iron from rust and decay and was found to be very much better than red lead. He did not think lithopone was a genuine article, and he advised all users, whether they used it for a water paint or for an ordinary paint, to be careful with it, otherwise it would play them tricks.

Mr. NOEL HEATON did not agree with the author's remarks with regard to white paint, for instance, where he said it was not right to use dryers with zinc white. His experience was that if that was not done it was very difficult to get the paint to dry properly; nevertheless he agreed that the use of dryers in zinc white very often caused considerable trouble. That was one of the disadvantages of the use of zinc white compared with white lead. With regard to the poisonous qualities and the susceptibility to discolouration of white lead by sulphur, the author did not mention anything about the improved white leads which had recently been brought out, particularly in America. He was assured that Hannay's process gave a white pigment of exceeding good body and covering power; and being fully oxidised and saturated with sulphur it was not attacked by sulphur, and being insoluble it was practically non-poisonous. It would be interesting to know how modern oxidised white leads compared in practice with such pigments as zinc white. He was opposed to ready-mixed paints, partly on the score mentioned by Mr. Crace, and also because if paint was ground and stored, the difficulty arose of the pigment settling out from the oil, and to obviate that it was necessary to emulsify the vehicle, which opened the door to a great deal of sophistication on the part of the manufacturer. Although there was a very great deal to be said against them on that score, they possessed advantages in their handiness, and because of the benefit derived from grinding and mixing pigments on a large scale with properly equipped plant. He believed that in North Dakota organised exposure tests were being made, but there were many questions connected with paint which were susceptible of being worked out in a thoroughly scientific manner, which ought to be put on a sound basis once for all. It needed some authoritative body to take the matter up and carry out definite experiments.

Mr. JENNINGS, in reply to the Chairman's remarks, said it was obviously quite impossible for him to cover in his paper the many points to which Sir William had alluded, but he hoped within a year or two the Society would give him the opportunity of reading another paper on those questions. He thought exposure tests were quite practicable, and ought to be carried out. Fifteen years ago he was engaged in America in carrying out somewhat similar experiments with regard to colours and varnishes. It was quite true that there was a great multiplicity of pigments, but it would only be necessary, in the first place, to experiment with the principal half dozen, including white lead, zinc oxide, barytes, lithopone, and graphite. If paints of known constituents could be exposed for a given time and the results classified, valuable information would be obtained. Graphite paint was made of plumbago, precisely the material used in black lead or polish, with the exception that the physical structure varied. It also contained a certain amount of silica, the plumbago being too thin to use by itself; but whatever the condition in which it was used, he knew from observation that it made an exceedingly fine paint for the protection of iron work. With regard to his remark as to 5 to 10 per cent. of barytes being added to white lead, the statement he made was that he did not think such a percentage of barytes would take away from the wearing qualities of the white lead. He thought it would add to the durability, rather than otherwise, and that so small a percentage would not take away, to any serious extent, the covering power, body or opacity. The respective drying qualities of petroleum and turpentine in paint was an interesting point, it having been a debatable question, for the last twenty years, as to exactly what the effect of turpentine was in paint. With regard to it causing cracking, he only referred to zinc oxide, and not to other paints. A book, recently published in America, which contained the results of elaborate experiments, proved that zinc oxide did not crack when turpentine was not used, except very sparingly. Lithopone was a very excellent paint to use inside buildings, but manufacturers did not claim it was of great service for outside use. It was quite true that when water was used in any paint remover it was a drawback. The paint removers to which he made reference contained no water, but only spirit which largely evaporated. He was most interested in Mr. Crace's remarks as to Portland cement removing paint, as he had recently been conducting

some experiments with Portland cement as a protective paint for iron. It had considerable good qualities in that respect, but how far he did not know.

The CHAIRMAN, in proposing a vote of thanks to the author for his paper, said that architects constantly specified that the joints of steel structures should be covered with Portland cement.

The resolution having been carried, the meeting terminated.

BRITISH TRADE WITH CANADA.

Mr. Richard Grigg's report upon the conditions and prospects of British trade in Canada has just been issued, and contains much information of value to home traders. Its conclusions are not new, and most of its facts are to be found in other publications if diligent search is made, but in Mr. Grigg's report they are seen in convenient form, and rest on the latest statistics. Mr. Grigg went to Canada as the special commissioner of the Advisory Committee of the Board of Trade on commercial intelligence, and he was there several months enquiring into the conditions governing British trade relations with Canada, and how best foreign competition can be met. At present the only very serious competitor is the United States, for German imports, which were making rapid headway up to 1903, have shrunk to little more than half since the surtax on German goods came into operation in that year, and increased duties on German goods $33\frac{1}{3}$ per cent. beyond the tariff common to all imports other than British. American imports continue to grow, whereas British relatively decline. In the triennial period 1892-4, 35·54 per cent. of the total imports into Canada came from the United Kingdom and 45·62 from the United States; in the triennial period 1904-6 the percentage of British imports had, notwithstanding the preferential tariff, fallen to 24·57, and from the United States had risen to 59·63. It must be borne in mind that a considerable part of the imports from the United States consist of commodities with which the United Kingdom does not, and in the main, cannot compete. Deducting the value of these natural products from the total importations into Canada, and from the United States imports, the British percentage is of course increased and the United States percentage diminished, but the same British decline and United States increase in the last triennial period are shown, the respective percentages being 31·3 and 48·5 as against 32·3, and 46·6 in the triennial period 1901-3.

Is it possible for the British manufacturer to redress the growth? Mr. Griggs argues that to some, and, perhaps, not an inconsiderable, extent it is. But there are many difficulties in the way. Not only is the time occupied in the transport of American goods very much less, but the United States manufacturer finds it far more easy to maintain a detailed acquaintance with the Dominion market, its needs, and conditions than does his British competitor. He is already familiar with similar conditions in his own country; by his travellers and by personal visits he can keep in close and almost daily touch with them, and the general mode of life and of industry in Canada is so closely akin to that prevalent in the United States that there is no such necessity for the United States manufacturer to depart to any considerable extent from the line of production and methods which he adopts for his own market as there is for the British manufacturer. Still the latter might do a good deal towards equalising the conditions of competition if he would pay greater attention to Canadian commerce and custom. Take the case of structural iron and steel. Canada has adopted the United States standards, and her architects and builders are accustomed to them, yet it is only very seldom that British manufactures can be induced to quote on American specifications, or produce according to them, so the orders go to the United States. What may be done in the way of recovery of lost position has been shown by the British makers of felt hats who, after being much inferior to their American competitors in the Canadian market, have in recent years reversed their position, simply by careful attention to Canadian styles. In the textile trade—which forms the strongest and most secure part of British trade with Canada—Canadian buyers recognise much greater efforts on the part of British manufacturers to meet the requirements of the market, and the same is true of the comparatively small trade in boots and shoes.

Mr. Grigg considers that British manufacturers should study Canadian conditions for themselves, and not depend so much as they have done in the past upon merchants or agents. They must follow the example of their American competitors in entering as much as possible into direct connections with Canadian buyers, and they must turn their attention more than they have done in the past to the problem of distribution under the new trade conditions which prevail to-day. Efforts should be made, too, to promote and encourage facilities for quick and cheap transportation and communication. Much of Canada's trade goes to the United States, not because of the superiority of the United States products, but because the goods required can be obtained more rapidly and promptly from that country than from the United Kingdom.

There is little time to be lost in improving trade relations if the British manufacturer is to keep his grip upon what he still holds, for not only is the competition of the United States becoming more formidable yearly, the Canadians themselves are becoming serious rivals. Although Canada is at present a country predominantly agricultural, it possesses vast industrial resources which, when a sufficient supply

of capital and labour is obtained, will make it a great manufacturing country also. And whilst German competition is at present almost insignificant, should the intermediate tariff be applied, as it may be as the result of negotiations already opened, German competition might have very serious consequences for British trade. At present, German goods are subject not merely to the general rates of duty, but also to a surtax of $33\frac{1}{3}$ per cent., the duty on German goods being therefore double that on British goods.

PARAGUAYAN RUBBER.

The principal rubber-producing trees and plants of Paraguay are (*a*) a species of the *Hancornia speciosa*, called by the natives "mangá icé," or "mangaba," (*b*) the *manihot glaziovii* of the mandioca species, and (*c*) many varieties of "lianas" or vines, which grow in the forests of the Paraguayan Chaco. The "mangá icé" is abundant in the northern section of Paraguay, and is also found in the southern and central parts of the Brazilian State of Matto Grosso. It grows wild in open spots and in the clearings round the edges of the forests (but never in the forests themselves), and in the sandy soil so widely distributed over Paraguay. According to the United States Consul at Asuncion, the tree attains a height of from 15 to 20 feet, and bears a small fruit annually. This fruit contains the seed, and attempts at cultivation have shown that the entire fruit must be planted to ensure germination. The wild growths of the mangá icé are widely distributed, but experiments have demonstrated that the tree responds quickly to cultivation. Ground is prepared for a nursery, in which the fruit-bearing seeds are planted, and where the young shoots may be protected and shaded. The trees grows rapidly, and are ready for tapping in from five to seven years. Some of the largest trees are reported to be from five to six feet in circumference. In the experimental nurseries, started some time ago, 60 per cent. of the seed germinated and produced healthy plants. Experiments made as to the yield of rubber from the plants give an average of about one half pound of gum from the first tapping. Subsequent tappings give better results, and large trees have yielded over four pounds of rubber. There are immense numbers of the mangá icé in a wild state, but their growth is widely scattered, and makes the cost of production rather expensive, more especially as labour in Paraguay is scarce. It has been estimated that 300 trees may be planted to each hectare ($2\frac{1}{2}$ acres) and that upon reaching maturity the trees may be tapped every three years. This latter is a somewhat undetermined point, as some claim that the tree may be tapped with safety every year. The quality of rubber derived from the mangá icé is not of the best, but this may be due in a measure to the rather crude manner in which the sap is coagulated, and the lack of capital to carefully handle and prepare the product. Coagulation is now effected by placing the sap—a white liquid of about the consistency of cream—in water to which a small quantity of alum has been added. The second class of rubber-producing trees of Paraguay is the *Manihat glaziovii* of the mandioca species. This tree, it is said, is also found in Brazil, and is also reported as being cultivated successfully in Ceylon and in the Congo Free State. It is a tree of rapid growth, and in Paraguay is found in the Chaco or western portion of the country, where its growth is not confined to any particular soil, as it is found in swampy land, as well as in the semi-arid sections of the northern Chaco. Little is actually known in Ascuncion of the value of the product of the "manihot," as nurseries set out some time ago were abandoned on account of lack of capital, but the rubber of this tree is said to be much superior in quality to that of the mangá icé. The sap—also white—coagulates upon exposure to the air, and the trees are said to grow to a height of about forty feet, and first tappings from young trees yield about one half-pound of rubber. The production increases yearly until a maximum yield of from ten to twelve pounds is secured. The *Manihot glaziovii* is reported to be the most valuable of the rubber-producing trees of Paraguay. The different trees mentioned may be grown or cultivated successfully in the same plantation, although the young shoots of the "manihot" must be fenced to protect them from animals who are fond of the tender shoots. The last group of rubber-producing plants found in Paraguay, the "lianas" or vines are reported to yield a considerable quantity of sap, and from the majority of these plants the gum may be extracted by the use of machinery, probably a process similar to that of treating the "guayulé" shrub of Mexico.

THE LIBRARY.

The following books have been presented to the Library since the last announcement:—

Amstutz, N. S.—Handbook of Photo-Engraving Third Edition. Chicago: Inland Printer Co., 1907. Presented by the Author.

"Artifex" and "Opifex."—The Causes of Decay in a British Industry. London: Longmans, Green, and Co., 1907. Presented by the Publishers.

Beadle, Clayton.—Chapters on Papermaking. Vols. 3 and 4. London: Crosby Lockwood and Co., 1907. Presented by the Publishers.

Bernthsen, A., Ph.D.—A Text-book of Organic Chemistry. Edited by J. J. Sudborough, D.Sc. London: Blackie and Son, Ltd., 1906. Presented by the Publishers.

Bridgett, R. C., M.A., B.Sc., and William Hyslop, M.A., B.Sc.—Trigonometry. London: Blackie and Son, Ltd., 1907. Presented by the Publishers.

British Rainfall, 1906.—Edited by H. R. Mill, D.Sc. London: E. Stanford, 1907. Presented by the Editor.

Bunau-Varilla, Philippe.—Le Détroit de Panama. Paris: Dunod et Pinat, 1907. Presented by the Author.

Carey, Alfred E.—The Mammoth Hunters. London: Greening and Co., Ltd., 1907. Presented by the Author.

Day, Lewis F.—Enamelling. London: B. T. Batsford, 1907. Presented by the Publisher.

Day, Lewis F., and Mary Buckle.—Art in Needlework. Third Edition. London: B. T. Batsford, 1907. Presented by the Publisher.

Dewhurst, Wynford.—Impressionist Painting. London: George Newnes, Ltd., 1904. Presented by the Author.

Endecott, F. C.—A School Course in Physics. Light and Sound. London: Blackie and Son, Ltd., 1907. Presented by the Publishers.

Hardingham, George G. M.—Patent-Rights. London: Crosby Lockwood and Son, 1908. Presented by the Author.

Hawkins, Cecil, M.A.— Elementary Geometry. London: Blackie and Son, Ltd., 1907. Presented by the Publishers.

London County Council.—Report, 1906-7. London Statistics, 1906-7. Presented by the London County Council.

Major, H., B.A., B.Sc.—Moral Instruction. (Middle Stage.) London: Blackie and Son, Ltd., 1907. Presented by the Publishers.

Morgan, R. B., B.Litt., and E. J. Balley, B.A.—Readings in English History from Original Sources. Two Vols. London: Blackie and Son, Ltd., 1906-7. Presented by the Publishers.

New South Wales Statistical Register for 1905 and previous years. Sydney: W. A. Gullick, 1907. Presented by the Agent-General for New South Wales.

New Zealand Official Year Book, 1907. Prepared by E. J. Von Dadelszen. Wellington: John Mackay, 1907. Presented by the Registrar-General.

Pearson, Henry C.—What I saw in the Tropics. New York: The India Rubber Publishing Co., 1906. Presented by the Publishers.

Praagh, L. V.—The Transvaal and its Mines. (The Encyclopedic History of the Transvaal.) Johannesburg: Praagh and Lloyd, 1906. Presented by the Transvaal Government.

Reynolds-Ball, Eustace.—The Tourist's India. London: Swan Sonnenschein and Co., Ltd., 1907. Presented by the Author.

Stirling. Amelia H., M.A.,—A Sketch of Scottish Industrial and Social History in the Eighteenth and Nineteenth Centuries. London: Blackie and Son, Ltd., 1907. Presented by the Publishers.

Thouaille, Albert, and E. E. Whitfield, M.A.—First Steps in Commercial French. London: Blackie and Son, Ltd., 1907. Presented by the Publishers.

Topham, Alfred F., LL.M.—Principles of Company Law. Second Edition. London: Butterworth and Co., 1908. Presented by the Publishers.

Victorian Year-book, 1906-7.—Melbourne: J. Kemp, 1907. Presented by the Government Statist.

HOME INDUSTRIES.

The Iron and Steel Industry.—A good deal just now is said of a discouraging character about the future of the iron and steel industry. According to the pessimists, its prosperity has passed never to return. The United States and Germany have forged ahead of us, and every year we shall fall farther into the rear. That relatively these two countries have gained upon us in recent years is indisputable, but from this admission to the conclusion that we cannot remain a great and prosperous iron and steel producing country for generations to come is a long one. None can forecast the future, but this it is safe to say that if the event justifies current forebodings it will be our own fault. Germany and the United States—to take the only too serious competitors with whom we have to reckon—have no natural advantages superior to our own. On the contrary we are better placed. Our coal is better than German coal, and cheaper; our iron ore is better; our coal and iron are much nearer each other. The raw materials of steel manufacture cost much more to get together in Germany than with us. With us, in the chief iron district, coal, iron ore, limestone, and blast furnaces are all within a radius of about twenty-five miles, and the finished product in Germany has to be carried much larger distances to a shipping port than with us. And so with the United States. Her natural resources are, of course, immense; but the difficulties she has to reckon with are sometimes forgotten. It costs her nearly twice as much to carry ore to furnaces as it costs us to carry Spanish ore to our furnaces, and about five times as much as to get our own ore to Cleveland furnaces. In England, coal and ore, and furnaces, and mills, and shipping ports are almost side by side; in America, owing to the situation of the coalfields, the principal rolling mills are from 400 to 500 miles from a seaport. Taking the last seven years, the average prices of pig-iron in America have ranged from 6s. to 29s. per ton higher than our own. Huge steel plants are being erected at the present time in the United States, but they are so enormously costly in proportion to their productive capacity that successful competition with us is most unlikely. And yet it is said that America and Germany will soon be leaving us hopelessly behind in the export trade. Should that happen, it will not be because the natural advantages of those countries are greater than our own, but because their technical training and commercial organisation are superior. But there is no sufficient reason why training and organisation with us should not be made as good as it is in Germany and the United States.

The Leather Trade.—The leather trade, as judged by net profits, was less satisfactory last year than in 1906. Taking nine leading companies, representing nearly all branches of the trade, the accounts show in the case of six of them smaller net profits, although only in one case was the dividend smaller, and this notwithstanding that the aggregate earn-

ings declined about 12 per cent. The fall in the price of raw material at the end of the year must have been of great benefit to tanners and others, and the outlook for the current year is encouraging, and indeed brighter than for some years past. The cost of production is low, the demand for leather good, the American position is righting itself, and so far as can be seen trade is likely to be active throughout the year.

The Electrical Industry.—The progress of the electrical industries is strikingly shown in the new edition just published of Mr. Emile Garcke's well-known work, "The Manual of Electrical Undertakings and Directory of Officials." In 1896 when the first volume of the manual appeared, only 172 electrical undertakings were included, with an aggregate capital of £61,110,000. Last year the number of undertakings had grown to 1,314, with a capital of £340,123,000, whilst the new volume deals with no less than 1,452 undertakings with a combined capital of £366,584,000. The growth in municipal electrical undertakings is very marked as between 1907 and 1908. The totals show an advance in number of no fewer then 116 municipalities with a total of nearly £10,000,000 extra capital. Of this sum 46 additional traction undertakings account for nearly £6,000,000. while supply undertakings have increased by 70, with an addition of £2,544,000 in total capital. An interesting table shows the average rate of dividend or interest on the capital issued by the various groups. In three – the telephone, manufacturing and miscellaneous—the average rate paid has been increased, although the improvement is small. In the telephone group an increase of capital amounting to £1,527,000 only is shown, but an increase of nearly £17,000,000 in capital has taken place in the case of traction companies, although only three additional companies are included in the list.

Nottingham Lace Workers.—The evidence taken by the Select Committee of the House of Commons on Home Work, shows among other things the very poor pay of most of the home workers in the Nottingham lace trade. The conditions vary considerably, but those of the workers who earn anything like good wages are few. The work appears to be divided into three grades. In the first called drawing, which is largely unskilled, the payment is from 1½d. to 2½d. an hour; in the second called clipping and scalping, which is the common or medium qualities done by the majority of home workers, the payment is from 2d. to 4d. an hour; and in the third grade, comprising the best qualities, and most extreme styles, done by the most experienced workers, the payment is from 3d. to 5d. an hour. The employment is very irregular owing to the continual changes in the styles of lace. One style may give employment to a large number of home workers, while another may give little or none. Since the Commission has been sitting the lace manufacturers have decided on a minimum tariff for home work, and 120 out of 180 firms have signed it.

The Jute Industry.—The remarkable growth of the jute manufacturing industry in India is shown by particulars given by Mr. Wighton, the Chairman of the Indian Mills Association, at the recent annual meeting of that body at Calcutta. He estimated the capital invested in buildings and plant on the banks of the Hooghly at £12,000,000, and the working capital at £10,000,000. Employment is given to 200,000 native operatives, whose wages amount to about £3,000,000 a year. Sixteen years ago only 8,000 looms were running, now there are 20,000. The thriving condition of the industry is shown by the fact that the output last year was 18 per cent. larger than that of the previous year.

The Factory Acts. — Miss Adelaide Anderson presents a cheerful view of the working of the Factory Acts. Miss Anderson is the principal woman Inspector of Factories, and lecturing at Bradford College the other day she held that progress has been steady, and incidentally she had a good word to say for the attitude of the Master Cotton Spinners towards reform. Analysing the factory legislation of the last century, Miss Anderson noted how the humane spirit, which awoke towards the end of the eighteenth century, directed its efforts first against slavery, then for the betterment of the prisons, and finally to the remedying of the conditions of child labour, with the Act of 1802 for the result. From that point developed legislation of wider scope, embracing labour in mines, the employment of women, sanitation, accidents, and many economic questions. Between 1802 and 1907 no less than 42 Factory Acts were passed.

Speed Recorders.—The attention of the Board of Trade has no doubt been given to the regulation issued by the Minister of the Interior in France, requiring all main line passenger locomotives to have speed recorders. Several of the most serious of recent accidents on our railway lines have been due to the locomotive drivers' tendency to take curves at the highest possible speed. The speed recorder is intended to stop this most dangerous practice by recording it. The Eastern Railway of France is fitting all its locomotives with a machine devised by its chief designer. This instrument indicates on a dial and records on a chart the speed of the locomotive as determined by the speed of rotation of the driving-wheels. This method does not give absolute accuracy, but the errors are said to be greatest at low speeds when they are of least consequence. It gives a rough idea of the speed, and that is sufficient for the purpose for which it is required, namely, to bring home to the driver his disregard of regulations. The instrument is not of the centrifugal type, but is based on the distance moved in given intervals of time, those distances being recorded automatically and continuously as a curve on a chart.

CORRESPONDENCE.

IRRIGATION IN EGYPT.

In a paper read at a meeting of the Royal Society of Arts on the 25th February, Sir Hanbury Brown took me severely to task for criticising the late Sir Benjamin Baker, and added that I was moreover in error when I stated before the Khedivial Geographical Society that the Assuan dam was being raised by seven metres or one metre higher than my project, for it was being actually raised by five metres or one metre lower. What Sir Hanbury Brown said was in accord with his chivalrous nature, but I confine myself to the facts.

I am afraid Sir Hanbury Brown was so carried away by his feelings that he forget his engineering. When one says that a reservoir dam is to be raised by six metres, the meaning is that the dam is to be so raised that the high water level of the reservoir is to be made six metres higher. Reference is never made to the roadway of the dam, which is a pure accident. I quote from Sir William Garstin's report in the *Journal Officiel* of the 15th of March, 1905:—"I agreed with Sir William Willcocks that the existing dam be raised by six metres above the present maximum level permitted in the reservoir." It is now being raised by seven metres. My facts, as distinct from my morals, are absolutely correct, and when Lord Cromer, commenting on Sir Hanbury Brown's paper, takes me to task for only reading his report and not those of Sir William Garstin and Sir Benjamin Baker, his criticism is quite superfluous, for what I did read were the reports of the two engineers, and I forgot to read Lord Cromer's. I trust you will kindly publish this letter.

W. WILLCOCKS.

Constantinople, 17/3/08.

Sir William Willcocks states that his facts are absolutely correct, and suggests that my feelings so carried me away that I forgot my engineering. As regards "my engineering," I would only point out that my paper contains the remark, "it is the high-water level of the reservoir that will be raised by 7 metres."

As regards the facts, I think Sir W. Willcocks should have remembered that, when he was delivering a lecture to the Khedivial Geographical Society, he was not addressing an audience possessed of a knowledge of engineering sufficient to enable them to put a correct interpretation on his remarks about the raising of the dam; and it would, in any case, have been better, in stating the facts on which his criticisms of Sir Benjamin Baker were based if he had been careful to avoid ambiguity of expression. "Egypt," No. 2 (1907), includes a note by Sir Benjamin Baker in which is this sentence:—"The existing dam and locks may be easily modified so as to admit of the level of water being raised seven metres, without introducing any element of danger whatever, or impairing the present factor of safety." There is no ambiguity about that.

In Sir W. Willcocks's lecture of 21st December, 1907, he states:—Works, which will take five or six years to complete, are being undertaken to raise the dam seven metres and widen it to five metres." Are we to understand that the expression "raise the dam" refers to the high-water level of the reservoir, while the expression "widen it" refers to the dam? If so, Sir William Willcocks's facts may be "absolutely correct," but his method of presenting them is no more exact than the sentence he quotes from the *Journal Officiel* of the 15th March, 1905.

I may here point out that, in Sir B. Baker's note, referred to above, it is further stated, concerning the Assuan Dam that, "Now that the apron is completed, the level of water may be raised 1·50 metres, without carrying out any works at the dam or locks." The situation is then, this:—The dam, as it existed, without addition, was capable of holding up the reservoir water level to 1·50 metres above R.L. 106, that is, to R.L. 107·50. The dam is being so added to and modified that it may hold up a further 5·50 metres, that is to R.L. 113. The roadway of the dam when so modified, will be 5 metres higher than it is at present. That I believe to be an "absolutely correct" statement of the facts.

HANBURY BROWN.

Newlands.
March 25th, 1908.

OBITUARY.

A. G. STANTON.—Mr. Arthur Gwyer Stanton, of the firm of Messrs. Gow, Wilson and Stanton, Limited, died on Wednesday night, the 18th inst., in consequence of a severe attack of influenza. Mr. Stanton joined the firm in 1885, and up to the time of his death took an active part in the management of the business. He was an acknowledged authority on the statistics of the Tea Industry, and prominent in all matters connected therewith.

Mr. Stanton was elected a member of the Society of Arts in 1887, and on January 23rd, 1895, he read a paper on "Tea," for which he received the Society's silver medal. On May 12th, 1904, he contributed a paper to the Indian Section on "British Grown Tea." He not only read two papers himself but compiled for Mr. G. W. Christison's paper ("Tea Planting in Darjeeling," 1896) a valuable table showing the gradual displacement of China tea since 1866, with percentage of each kind used and quality of all tea per head of population. He was a prominent member of the Indian Tea Association and a member of the General Committee. His kind and genial manner endeared him to a large circle of friends.

GENERAL NOTES.

Raw Wax.—Formerly large shipments of raw wax were made from Persia to India and Europe, but owing to the production of wax from mineral oil and its comparative cheapness, the beeswax industry in Persia received a heavy blow. In his report upon the trade and commerce of Bushire (Cd. 3727-34), Mr. Vice-Consul Chick says that the iucrease in the cultivation of the poppy seems to have driven away the bees from many of the honey-producing districts. Honey bees have seldom been known to yield honey in districts lower than Kazerun, but they are prolific wherever running water and verdure exist, and their management has been well understood by the peasants in the past. Pilgrims to Kerbela and the holy places carry with them an appreciable number of wax candles, and in Russia, where the Orthodox churches consume only wax candles, to the exclusion of other kinds, their loss is stated to be large. Small shipments of wax sometimes take place to Antwerp and Germany from Bushire.

Rubber in Colombia.—As but few indiarubber plantations have been made in Colombia, in his report just issued (Cd. 3727-39), Mr. F. Strange, His Britannic Majesty's Minister at Bogoté, says that there is one at Ceara Manchiot, some three days journey from the capital, which is said to have produced some good samples, so it would seem that the production of this article might be very much increased, but foreign capital and enterprise are required. The wild rubber comes from remote parts of the republic, which are very difficult of access. Here, again, a considerable outlay of capital would be necessary before the trade could be developed. The natural outlet of the rubber districts is by the Amazon, and it is believed that the Treaty which has recently been negotiated with Brazil will, when ratified and put in force, afford far greater facilities for exportation than have existed hitherto.

Marine Motors in Japan.—Quite a growing industry seems to have sprung up in Japan in marine motors. In his report on the trade of Kobe (Cd. 3227-25) Mr. Consul Bonar says that the number of boats (sea-going) using marine motors of Japanese make is fast increasing, and there would seem to be in this line an excellent opening if British manufacturers would give the matter their attention. For some time past a large number of Osaka river boats have been using petrol motors, of which the first supplies came from the United States. These appear then to have been copied, and in some cases, it is claimed, improved upon, so that now the majority of the motors used on the river craft are of Japanese manufacture. Though somewhat noisy and evil-smelling they appear to answer the purpose, and therefore in that line—unless something cheaper or better of foreign manufacture can be put on the market—the Japanese motor manufacturing works will have it all their own way. But for sea-going craft, simple but reliable motors of 12, 15, 20, and 30 horse-power, using common kerosene oil—paraffin (the latter is obtainable at every little seaport or village), should have, the Consul thinks, a large sale provided the price were reasonable. The British manufacturer should remember, however, that by manufacturing on the spot he will save 50 per cent, import duty on a motor as a whole or any part thereof which would otherwise be imported into Japan.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

April 1.—"Dr. Schlick's Gyroscopic Apparatus for Preventing Ships from Rolling." By M. Wurl. Sir William Henry White, K.C.B., F.R.S., will preside.

April 8.—"Technical Education in America." By Sir William H. Preece, K.C.B., F.R.S. Charles Moberly Bell will preside.

April 29.—"Modern Roumania." By Alfred Stead, Consul-General for Roumania. Sir Percy Sanderson, K.C.M.G., will preside.

May 6.—"The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds." By Lovell N. Reddie.

May 13.—

May 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. Martin Duncan.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

April 30.—"Reminiscences of Indian Life." By the Right Hon. Lord Lamington, G.C.M.G., G.C.I.E., late Governor of Bombay.

May 21.—"The United Provinces of Agra and Oudh." By Sir James John Digges La Touche, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

April 7.—"The Imperial Problem of Asiatic Immigration." By Richard Jebb. The Right Hon. Alfred Lyttelton, K.C., M.P., will preside.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

March 31.—"Enamel Portraits." By Cyril Davenport, F.S.A. Sir Hubert von Herkomer, C.V.O., R.A., will preside.

April 28.—"Lace as a Modern Industry." By Miss Isemonger. Alan S. Cole, C.B., will preside.

May 26.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

PROFESSOR VIVIAN B. LEWES, "Fuel and its Future." Four Lectures.

LECTURE IV.—MARCH 30.—The internal combustion engine *versus* steam—Gaseous fuel and power production—The utilisation of peat—The regeneration of Sun energy when our present fuel supplies are exhausted—Alcohol as a fuel, and its possibilities.

WILLIAM BURTON, F.C.S., "The Nature and Structure of the Porcelains." Three Lectures.

May 4, 11, 18.

SHAW LECTURES ON INDUSTRIAL HYGIENE.

Friday evenings, at 8 o'clock :—

MAY 15.—"The Dangers of Coal Dust and their Prevention." By W. E. GARFORTH, President of the Colliery Proprietors' Association of Great Britain.

HOWARD LECTURES.

Thursday evenings, at 8 o'clock :—

H. S. HELE-SHAW, LL.D., F.R.S., "The Navigation of the Air." Three Lectures.

LECTURE III.—APRIL 2.—Contrivances in which the force of gravity is opposed dynamically—The methods adopted in nature—Birds, flying reptiles, flying animals, and flying fish—The stability and resistance of an aeroplane—Kites, parachutes, and the gliders of Lilienthal, Pilcher, Chanute, and the Wright Brothers—Lessons to be learnt from the use of models—Comparative features of the flying machines of Santos Dumont, Delagrange, Bleriot, and Farman, and others.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Vivian B. Lewes, "Fuel and its Future." (Lecture IV.)

Farmers' Club, Whitehall-rooms, Whitehall-place, S.W., 4 p.m. Discussion on "Local Taxation."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. F. C. Hunt, "Quantities: Should they form part of the Contract?"

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. J. Mackinder, "The Geographical Conditions affecting the British Empire. 1. The British Islands."

British Architects, 9, Conduit-street, W., 8 p.m. Paper on "Theatre Planning."

Actuaries, Staples-inn-hall, Holborn, W.C., 5 p.m.

TUESDAY, MARCH 31...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Cyril Davenport, "Enamel Portraits."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. A. Wallis Budge, "The Egyptian Sudan: its History, Monuments, and Peoples—Past and Present." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Ernest Richard Dolby, "Some Methods of Heating adopted in Hospitals and Asylums recently built."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. W. Bickerton, "The Camera as an Aid to the Study of Birds."

WEDNESDAY, APRIL 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C, 8 p.m. Mr. M. Wurl, "Dr. Schlick's Gyroscopic Apparatus for Preventing Ships from Rolling."

Geological, Burlington-house, W., 8 p.m. Mr. J. Frederick N. Green, "The Geological Structure of the St. David's Area (Pembrokeshire)."

Royal Archæological Institute, 20, Hanover-square, W., 4½ p.m. Professor Haverfield, "Roman Inscriptions in Britain."

THURSDAY, APRIL 2...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lecture.) Professor H. S. Hele-Shaw, "The Navigation of the Air." (Lecture III)

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. Hans Gadow, "Altitude and Distribution of Plants in Southern Mexico." 2. Miss Winifred Smith, "The Anatomy of some Sapotaceous Seedlings." 3. Dr. N. Annandale, "Notes on some Sponges Recently Collected in Scotland."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. D. R. Boyd and E. R. Marle, "The Condensation of Epichlorohydrin with Phenols." 2. Mr. G. Senter, "Rate of Hydrolysis of Chloroacetates and Bromoacetates and of α Chlorhydrin by Water and by Alkali, and the influence of Neutral Salts on the Reaction Velocities." Preliminary Note. 3. Prof. F. D. Chattaway, "A New General Method of Preparing Diazonium Bromides." 4. Prof. W. N. Hartley, "The Probable Nature of the Impurity found in the Triphenylmethane Spectrum." 5. Mr. A. G. G. Leonard, "The Absorption Spectrum of Tryphenylmethane." 6. Mr. S. S. Pickles, "The Constituents of Cyprus Origanum Oil. Isolation of a new Terpene (Origanene)."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Lydekker, "The Animals of Africa." (Lecture I.)

Civil and Mechanical Engineers, Caxton-hall, Westminster, S.W., 8 p.m. Mr. C. Humphrey Wingfield, "Efficiency of Boiler Heating Surface."

Electrical Engineers, 25, Great George-street S.W., 8 p.m. Messrs. G. Stoney and A. H. Law, "High-Speed Electrical Machinery."

FRIDAY, APRIL 3...Royal Institution, Albemarle-street, W., 9 p.m. Lord Montagu of Beaulieu, "The Modern Motor Car."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. G. W. N. Rose, "Notes on the Foundations of an Indian Bridge."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7½ p.m. Mr. E. Hall Craggs, "The Framing of Vessels."

Architectural Association, 18, Tufton-street, S.W. 7½ p.m. Mr. Lewis F. Day, "Originality and Tradition in Design."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, APRIL 4. Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. J. Thomson, "Electric Discharges through Gases." (Lecture V.)

Journal of the Royal Society of Arts

No. 2,889. VOL. LVI.

FRIDAY, APRIL 3, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

TUESDAY, APRIL 7, 4.30 p.m. (Colonial Section.) RICHARD JEBB, "The Imperial Problem of Asiatic Immigration."

WEDNESDAY, APRIL 8, 8 p.m. (Ordinary Meeting.) SIR WILLIAM PREECE, K.C.B., F.R.S., "Technical Education in America."

Further details of the Society's meetings will be found at the end of this number.

MR. BURTON'S CANTOR LECTURES.

Mr. WILLIAM BURTON, in consequence of the pressure of other work, is unable to fulfil his engagement to deliver the course of Cantor Lectures on "The Nature and Structure of the Porcelains," announced for Mondays, May 4, 11, and 18. The course will therefore not be given this Session.

CANTOR LECTURES.

On Monday evening, 31st inst., PROFESSOR VIVIAN B. LEWES delivered the fourth and last lecture of his course on "Fuel and its Future."

On the motion of the CHAIRMAN, a vote of thanks to the Lecturer was carried unanimously.

The lectures will be published in the *Journal* during the summer recess.

APPLIED ART SECTION.

Tuesday evening, March 31; ALEXANDER FISHER in the chair.

The paper read was on "Enamel Portraits." By CYRIL DAVENPORT.

The paper and discussion will be published in a future number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

Tuesday afternoon, March 24; H. E. ADMIRAL SIR FREDERICK G. D. BEDFORD, G.C.B., in the chair.

The paper read was—

THE MINERAL RESOURCES OF WESTERN AUSTRALIA.

By THE HON. C. H. RASON,
Agent-General for Western Australia.

It was in 1885 that gold in any appreciable quantity was first found in Western Australia, the discovery being made by a party of prospectors led by men named Hall and Slattery on the Margaret and Ord rivers in the Kimberley division which forms the far northern portion of Western Australia. In the following year the fact that a new State had been added to the Empire's gold-producing countries was officially recognised by the proclamation of the Kimberley goldfield, although Kimberley, the pioneer field, cuts a very poor figure in the State's gold production to-day. It has been quite over-shadowed by the richer and more accessible fields in the southern part of the State. Nevertheless, he would be a rash man who would say that Kimberley's mining days are past or numbered. Its gold production has fluctuated very much during the last 23 years, but in no single year has it fallen to nil. The area of the proclaimed Kimberley goldfield (the remotest and least developed of all) is greater than that of all Scotland, and, since it is peopled by fewer persons than you would find in an English village, it is not difficult to believe that untold mineral wealth may yet be found in that part of Western Australia. Only a couple of years ago the Assistant Government Geologist, in

reporting on a silver-lead mine in the West Kimberley country, mentioned a fact which better illustrates the remoteness of that lonely territory in the far North-West of Australia than anything else I could cite. He said that the mine was situated on a river which, "although of considerable size," does not even find a place on the map!

Nearly every mineral of economic value known to geological science, including gold, silver, iron, copper, and tin, has been proved to exist in Kimberley, to what extent and in what degree of richness will some day be proved by the pioneer prospector and the enterprising capitalist, perhaps to the betterment of the world in general and the enrichment of Western Australia in particular.

For the past dozen years or so attention has been concentrated on the Coolgardie and Kalgoorlie and other proved fields in the more southern part of the State. Nor is that to be wondered at. In those years these fields have been producing from one million to two million ounces of gold per annum. In only one other country in the world has this rate of production been contemporaneously equalled. When you have several mines in one district turning out gold in fabulous quantities—some 100,000 ounces and others 150,000 ounces yearly—speculative interest is inevitably centred in the exploitation of the fields that give such immediate tangible results rather than in purely speculative work in unproven fields.

The first discovery of gold in the direction of what is now the extensive Eastern goldfield was made in 1887, in the Yilgarn hills, a then uninhabited, because arid, region some 200 miles beyond the farthest inland settlement of the day, and some 270 to 300 miles from the coast. The State was by this time fully alive to the immense possibilities of Western Australia as a gold-bearing country, and prospecting for auriferous reefs and alluvial deposits was carried still further eastwards and outwards by numerous parties of adventurous diggers, most of whom hailed from the other Australian States. These explorations led to the successive discovery of the Yilgarn, Coolgardie, Kalgoorlie, Menzies, and a number of other auriferous areas which are now included in the Eastern goldfields, where most of the great producing mines of the present are to be found. Similar prospecting in the Western and North-Western Divisions led to discoveries of reefs in those parts, which are now being mined at various points.

The story of the discovery of Coolgardie is one of the world's romances of gold-seeking. The discoverers were two Victorian miners, Messrs. Bayley and Ford, who had been prospecting on the Murchison. The expedition, which resulted in the discovery which has made their names famous in Western Australian history, was carried on under conditions that taxed the endurance, and proved the quality of these two men, as similar expeditions have proved the "grit" and resourcefulness of the mining pioneers all over Australia. Leaving Perth, in April, 1892, they struck out for the North-East, but, after traversing 250 miles, they lost their horses and had to turn back. Equipped with fresh horses, they started again on what again proved to be a long, tedious, and futile journey, for again they were forced to turn back—this time for want of water.

The third attempt won them fame and fortune. First they found that which to them then was more precious than gold—water. They found a natural well, known to the scattered tribes of that far-away country as "Coolgardie." Pitching their camp beside the well, they turned their horses out to feed, and started prospecting the country around. Ford picked up a half-ounce nugget, and before the night fell on their first day's labours in that lonely land, they had gathered in over 20 ounces of gold. Two or three weeks' more surface prospecting was rewarded with over 200 ounces.

By this time food supplies had given out, so, keeping their own counsel concerning their discoveries, they returned to civilisation, laid in a fresh stock of provisions, and hastened back to their El Dorado. Within a few days of their return they happened upon the reef that made Coolgardie a name to conjure with in mining camps and on Stock Exchanges the wide world over. Beginning with a "slug" weighing 50 ounces, they picked out from the cap of that reef in a few hours upwards of 500 ounces of gold!

Bayley, carrying 554 ounces of gold, journeyed back to the nearest mining town, exhibited his find to the mining warden, put in a claim for a lease of the land on which this marvellous discovery had been made, and hurried off to the field again with a party that numbered 150 men, besides coaches and horses, and all the paraphernalia of prospecting and camping. In their wake, in course of time, came gold seekers in hundreds and thousands.

At that time there was no railway within

250 miles of Coolgardie; no white settlement, no roads, no food supplies of any kind along the route, and precious little drinkable water. An official account tells us that—

"Men travelled through the waterless tract of country on foot, horseback, bicycles, and in vehicles of all descriptions, while food, stores and tools were sent forward by horses or donkey teams, or on long strings of camels. Along the track, with intervals between, were huge dome-shaped bosses of granite, some of which covered large areas of ground. On their tops and sides were holes and hollows that held water after rains, while along their bases were 'soaks' in the sand where water could be obtained in a few feet of sinking, but the supply was small and uncertain in view of the great demand being made on it. Enterprising men quickly began to do a thriving trade by condensing the salt water to be found plentifully along the route, and disposing of it to the thirsty teams at as much as 2s. 6d. per gallon, or even higher. Diggers swarmed over the flats for miles round Coolgardie, pegging out claims, which in a large number of instances yielded rich returns. A town sprang up as if by magic. Bag and 'hessian humpies' rapidly gave way to wood or iron structures, or to more permanent buildings of wood or stone. Coaches for mail and passenger traffic, and team upon team of horses and camels for the carriage of stores were rushed to the fields. The nearest telegraph station being 113 miles distant, messages were despatched by Afghans on swift camels, or by the corps of cyclists, which was soon established, to keep up regular communication, while the extension of the telegraph line was being completed."

From Bayley and Ford's mine (which, by the way, was floated into a company in London) there was taken in the first nine years of its history 134,000 ounces of gold, valued at £530,000, upon which £184,000 was paid in dividends. From the whole Coolgardie field nearly 900,000 ounces, of the approximate value of £3,500,000, have been taken.

In June, 1893, Flannagan and Hannan discovered the alluvial field named after Hannan, and later known as Kalgoorlie. A large quantity of alluvial gold was obtained by the 2,500 diggers who quickly swarmed over this new field; and of still greater importance was the discovery of some of the rich reefs of the Golden Mile, in the neighbourhood.

In 1894 the sensational discoveries of the Londonderry and the Wealth of Nations occurred. The Londonderry was found by a party of unsuccessful prospectors on their way back to Coolgardie. Two of them picked up some rich gold-bearing specimens. After a brief search, the outcrop of a reef was exposed, from which in the course of a few days they took out 4,000 to 5,000 ounces of gold. One specimen was estimated to be worth £3,500. From the cap of the Wealth of Nations reef gold to the value of £20,000 was secured in a few days. One specimen contained fully 8,000 ounces, and two nuggets of 197 and 147 ounces were secured.

The mines on this field (officially known as East Coolgardie, but generally associated in the public mind with the name Kalgoorlie) have yielded nearly 9,000,000 ounces of gold, of the approximate value of £36,000,000; and upon this field, which fifteen years ago was looked upon as desert country, there has grown up the city of Kalgoorlie, with a population of nearly 30,000, and said to excel many of the larger and older cities of Australia in some of the matters of advanced civilisation, such as electric lighting, electric tramways, telephones, &c.

As the work of prospecting and discovery proceeded, followed by the opening of the mines and general expansion and systematising of the gold-getting industry, the output of the metal increased by leaps and bounds year by year. In 1889 the yield reached nearly £60,000 in value; in 1891 it was £115,000. The following year it doubled; and, keeping up a marvellous rate of progression as new goldfields were opened up, it reached £1,206,000 sterling in 1896—the eleventh year of the gold production. For the following year, 1897, when the great Kalgoorlie mines had begun to contribute to the yield, the value rose to well over £2,500,000; and in 1898 948,564 ounces were obtained, the value being just over £4,000,000 sterling. Over £6,000,000 sterling was realised in each of the two following years; and the new century was inaugurated by a yield of £7,235,000 for 1901, followed by just under £8,000,000 for 1902. 1903, with an output of just under 2,750,000 of crude ounces (just giving over 2,000,000 of fine ounces), the value being £8,770,000, was the year of the highest yield up to date.

1904-5-6-7 show a decline in both quantities and values; but this is due not to any general "slump" in the mining industry, but to the decreased output of a few mines the previous phenomenal returns from which swelled the totals. To quote the latest report to hand from the Department of Mines of Western Australia (1906):—

"It may be pointed out that in nearly every case the reduced output may be accounted for by the diminished production from a very few mines, and in several cases the decrease for the goldfield may be

accounted for by the smaller output from one mine only, thus going to show that mining as a whole is on a sound footing. A decreased output can never be contemplated with equanimity, but when it can be shown that it is not caused by a general failure of mining operations, but rather by fluctuations in the production of some of the larger mines which are caused in all probability from prudence rather than necessity, and with a view to prolonging their life by treating larger quantities of lower grade ore, it may be regarded without much apprehension."

The 1907 output was about 27,000 ounces below that of 1906. But the tonnage crushed was roundly 80,000 tons greater than in 1906, the grade of ore falling from 50·54 shillings per ton in 1906 to 48·00 shillings per ton in 1907. This is not only because some of the big mines have become poorer, but is largely because cheaper methods of handling the ore have made it more profitable to work ore which formerly was unpayable. The falling off in production of gold is due to—

(*a*.) Decrease in the value of the ore in many of the principal mines as they are worked deeper. In the deepest mine in the State, however, values have been well maintained at the lowest depth, well over 2,000 feet.

(*b*.) More economical methods of working, taking out a larger tonnage of ore than formerly, but at a lower average gold content.

(*c*.) Exhaustion of the ore in several mines, which have been large producers in the past. This is a natural consequence of rapid modern methods of working out mines, and its effect can only be neutralised by active development of new mines to take the place of those worked out. In several cases lately, however, mines that have been considered worked out have developed fresh bodies of ore and taken a new lease of life.

(*d*.) Dulness in the mining market, making it impossible to open up new mines actively to replace those worked out, and discouraging prospectors from searching for fresh discoveries.

At the present time the annual gold output of Western Australia is only two or three points less than half of the total for the whole of Australasia. That is, this State produces nearly as much as the other five Australian States and New Zealand together.

Taking the grand totals of gold production for the twenty-three years from 1886 to the end of last year, we find that Western Australia has, during this period, produced the enormous quantity of over 18,000,000 fine ounces—roughly, some 750 tons of gold of the value of nearly £80,000,000 sterling.

Just think of it! This little community has won from the wide wastes of its great, sparsely peopled territory, in little more than twenty years, gold enough to build and equip a fleet of fifty *Dreadnoughts*.

The increase in dividends is not less remarkable than the growth of gold production. The working mines made a start in returning profits to the shareholders in 1890 with the insignificant total of £1,250. Nine years later the total amount paid in dividends by the gold-mining companies in one year exceeded £2,000,000 sterling! Owing to improvements in conditions of working, the dividends do not always bear the same proportion to the annual yield. For instance, the year of the record yield (1903) shows a slightly less amount paid in dividends than 1904, when the production had somewhat declined; while in 1905, with a still further decline in yield, the total of dividends paid was the highest on record (£2,167,639).

Approximately, the Western Australia gold-mines pay a sovereign in profit on every ounce of gold produced. Ten years ago the dividends averaged £5 on every 6 ounces. Five or six years later the results had improved, the dividends averaging in 1903 £5 on every five ounces. This relative improvement has continued ever since. Last year an output of 1,697,000 ounces yielded £1,738,000 in dividends, or rather more than one sovereign profit on each ounce of gold won.

During the earlier years of what may be termed the gold boom in the State I have the honour to represent, serious doubts were entertained as to the continuity or "permanence" of the lodes on the Eastern fields. These misgivings were founded on the "pockety" nature of the deposits unearthed about Coolgardie; and the question exercised many minds until the greater Kalgoorlie mines were opened up on a large scale and the lodes were found to maintain their auriferous character as they were followed down. Then the uncertainty vanished; and now a depth of over 2,000 feet on the lode has been reached on the Boulder reef, while over a dozen shafts in this district have been sunk more than 1,000 feet on good ore. As a rule, however, there is a falling-off in the grade of the ore as great depths are attained.

I would particularly point out that the present falling off in the production need not be the cause for the slightest anxiety as

regards the future of the gold-mining industry of Western Australia considered as a whole. Even if we must recognise that perhaps the "Golden Mile" group, which have constituted a world-wonder in the past few years, may not continue their phenomenal returns, we must remember that they are yet producing largely. In 1906 (which is the last year for which I have detailed returns) the East Coolgardie Goldfield (in which the Kalgoorlie group is situated) yielded only 8,000 ounces less than in the previous year, although the dividends amounted to £3,250 more. More ore had been taken out (nearly 15,000,000 tons in 1906 against under 1,300,000 tons in 1905), but the ore was of lower grade, being valued at 56 shillings as against 65 shillings in the previous year.

It may be that in the race for showing the largest annual return and paying the biggest dividend, it has been too much the fashion in the past to pull out all the good ore in sight and realise on it, without providing adequately for the expensive work of exploration at greater depths. This would seem to be the view of the State Mining Engineer in a lecture he recently delivered at Perth (W.A.). To-day, however, all the leading mines are making vigorous efforts to maintain their front position, strengthening themselves by active exploration at deep levels well ahead of the immediate requirements of the mills.

A feature in the methods of working which must be very gratifying to the shareholders in the gold mines generally in the State, and which is particularly marked in the case of the great Kalgoorlie group, is that the proportion of dividends to annual yields has increased to such an extent that the total amount of profits returned to shareholders reached its high-water mark in the second year of the decline of the yield. For instance, whereas a total yield of 1,871,038 fine ounces in 1902 resulted in £1,424,272 being paid as dividends, the lesser yield of 1,697,553 fine ounces for 1907 gave a profit returnable of no less than £1,738,163.

Taking the percentages, we find that the dividends paid by the mining companies rose from 25·2 per cent. of the total production in 1904, to 27·0 per cent. in 1907, a result far above that obtained in the sister gold-producing State of Victoria. This result conclusively shows that economy is combined with efficiency in working the leading Western Australian mines. The very latest scientific modes of working are adopted, the most up-to-date labour saving machinery is employed, and every economical device is brought into operation, with the result that although, owing to the lower grade of the ore, the value of the gold produced per man employed, above and below ground, has fallen from £459 in 1905 to £438 in 1906, the average tonnage of ore raised per man engaged on the mines in all Western Australia, has increased from 157 tons to 173. The average tonnage of ore raised per man employed in the East Coolgardie field is very high, viz., 248 tons, as also the average production per man, £701.

But, above all, it cannot be too widely known —for here lies the assurance of continued and increased prosperity for the mining industry of Western Australia—that in regard to the situation of the mining areas, the eggs are not all in one basket. The Golden Mile mines have taken the leading place in the public eye both on account of their extensive workings and their large yields. But they are not the only gold mines Western Australia possesses. In the lecture before mentioned the State Mining Engineer emphasises the point that the biggest mines being worked at full capacity their output figures in undue proportion in the total production. He points out that there are many other promising mines distributed over the auriferous areas of the State which might prove equally profitable if only equal attention and capital were devoted to their development. At the end of 1906 there were 35 mines in the State which had individually produced more than 50,000 ounces of fine gold, and these were well distributed over the immense gold-bearing areas.

Then, among the 1,150 producing gold mines in the State there are a host of smaller properties which together now supply more than one quarter of the total annual output of the State, but which were they fully developed and systematically and scientifically worked would soon make up the deficiency arising from the decline in the yield of the leading group. The State Mining Engineer remarks that in regard to many of these smaller mines, which have, nevertheless, produced over 10,000 ounces each, it is quite common to find that only a shaft some 200 or 300 feet deep has been sunk, and that very little or no prospecting development has been carried out. The gold near the surface has been dug out, and then the rich easily accessible deposit having been exhausted, these mines are considered as worked out; whereas, says the authority I am quoting, they have hardly begun to be worked from the point of

view of systematic mining. The industry was, he stated, still in its infancy; and there were hundreds of properties ready to take the place of the big mines provided the capital requisite for the proper working of these undeveloped properties is forthcoming.

Again, outside the developed and partially developed mines, is the immense extent of untouched auriferous country with reefs running through it literally for hundreds of miles. The total area held under gold mining leases in all the State was, according to the last return, only 30,000 acres represented by some 2,200 leases, and, as yet, but little even of that extent has been opened up. Here we have something like 50 square miles only held on gold-mining leases, although the total area of the nineteen proclaimed goldfields amounts in round figures to 315,089 square miles. This vast area of virgin gold-bearing country still awaits the prospector. Present operations are confined to only a few spots. Outside these there lies a vast field untried and of limitless possibilities. It is not beyond the bounds of probability that deposits as rich as those now being worked—or even richer—will be discovered. Only within the last three years or so the Black Range field in the East Murchison district has been opened up, with the result that in this new sphere of operations there are now a large number of producing mines, the yields from which form an appreciable contribution to the total production. Nearly 100,000 ounces came from the East Murchison field in 1906, as against 85,000 ounces in the preceding year.

The enormous area of mineral lands in Western Australia is far beyond the power of the present small population to develop thoroughly, and everywhere throughout the fields we find very numerous promising prospecting ventures lying idle, which are deserving of being followed up, and many of which would no doubt become good mines if they were well opened up. As time goes on these will be doubtless taken in hand and tried. In the present depressed state of the mining market, however, prospectors find it almost impossible to get the financial backing which they require in order to live while they are opening up new mines, and even harder to get enough capital to equip them with machinery when they have "proved" as far as possible by manual labour. The great incentive to active prospecting, namely, a ready market for sale of any good discovery the prospector may make, being thus absent, very little of such work is now being done, considering the great opportunities which are open on every side. With a revival of confidence and investment in mining there would undoubtedly be a great revival in prospecting, with consequent rapid improvement in the production of gold.

The known fields are continually having new discoveries made in them and being extended, but there is much reason to believe that there are huge areas in the State in which minerals occur which have hardly been looked at by prospectors.

A conspicuous instance of an extensive tract of gold-bearing country which awaits opening up is the Pilbarra district in the North-West, comprising an area of 35,000 square miles as a proclaimed goldfield. Although rich deposits have been discovered in various directions within this area, and initiatory work has been done at one or two centres here, the want of transport facilities has hitherto blocked the way for this field to become a leading contributor to the gold production as it will be when a railway between the coast and the field is provided.

Immediately south of the Pilbarra field again lies a vast stretch of country known to be rich in mineral wealth, but at present unexploited. To the mineral resources of this north-west region, at present only devoted in parts to the pastoral industry, the State must look for a principal source of its prosperity in the future. The auriferous reefs appear to have a course of hundreds of miles from the Eastern goldfields and those in the Western Division into this north-western region; and in the time to come, when the railway shall have been carried into this country and connections formed with the existing Eastern and Murchison railways, a chain of gold mines will connect all these parts, a broad golden pathway running from the South coast, on the 34th parallel, up right through the heart of the State, to what is known as the Pardu desert on the 20th parallel. There is auriferous country all the way, but as yet, for the most part, untouched—a virgin field of incalculable richness waiting to be won.

Rapid and wonderful in results as has been the progress of the mining industry of Western Australia up to the present, the immense mineral resources of this marvellous country have, as yet, only been tapped in a few places; and only a few mines have as yet been fully opened up, and worked to their full capacity. When the general revival in the industry comes and the new fields are thoroughly prospected,

I believe the results will cause the advancement made hitherto, to appear insignificant. Unlike the Transvaal, all the great mines of which are in one chain on one line of reefs, Western Australia has many gold-producing centres scattered over enormous stretches of its vast surface. The railway is a most important factor in the development of the mineral resources of the country. It has been carried hundreds of miles from the coast inland to the goldfields. But further extensions in several directions are necessary for the full exploitation of even the proved auriferous areas ; and these will gradually be carried out.

The policy of the Government of Western Australia has always been a bold and helpful one in connection with the development of the mining resources of the State, particularly in connection with the gold-mining ; and railways have been constructed to all the present leading gold-mining centres, even the nearest of which is far distant from the capital and the coast.

A prominent feature of the general mining industry of Western Australia is the State aid given in co-operation with, or in the absence of, private enterprise, principally for the benefit of the holders of small claims ; also for the encouragement of prospecting. By the erection of State batteries and provision of cyanide plants in remote and isolated spots which are at a distance from any of the leading centres of the industry or any of the big mines, much has been done to assist the workers of small gold mines who are unable to provide crushing mills and machinery for themselves. At the same time, the intention is that these reducing plants shall not be run at a loss for all time. Up to 1905 there was a loss of £11,000 on a total outlay of £90,000, but in 1906 there was a profit of £3,000. Since the inception of this form of State aid and up to the end of 1906 the public batteries had crushed, in round figures, 410,000 tons of gold ore for a yield of 456,000 ounces, valued at £1,683,000, besides 21,000 tons of tin ore, producing tin valued at £25,000. These figures show the value of the State assistance to smaller operators ; while as regards the public, the revenue from the batteries and cyanide plants (the charges for the use of which are fixed as low as possible) is sufficient to demonstrate that they are practically self-supporting.

In addition to assistance in the treatment of ores, the State helps to equip prospecting parties, and makes advances to struggling claim-holders to aid them in the development of their properties, in boring for lodes, and in working alluvial deposits. It also conducts undertakings for the supply of water on the goldfields, and cuts tracks to mines in the bush.

But the main work, besides the railway, initiated and carried out by the State for the benefit of the gold-mining industry in Western Australia is the gigantic undertaking for supplying water to the Eastern goldfields by pumping it through pipes from a river source on the Darling coastal range near the capital city of Perth, through the eastern agricultural districts, to a central reservoir near Kalgoorlie, and thence on to Boulder-Kanowna and Bulong, a distance of over 380 miles. This monumental feat of engineering was commenced in 1896 and completed early in 1903, the total cost being £3,000,000 sterling. The total revenue from sales of water from this supply during the financial year ending 30th June, 1907, was, in round figures, £167,000, while the working expenses only amounted to £65,000 (including provision of a reserve of £10,000), the surplus balance going to meet the annual charges for interest and sinking fund in connection with the loan raised for construction.

It is on the Eastern goldfields principally that waterworks are a prime necessity, the Murchison country in the Western division being for the most part well provided with natural surface supplies.

I think I should be justified here in laying some stress on the progress that has been made in railway construction and water supply. With the completion of the projected railways to Ravensthorpe, Norseman, Black Range, Meekatharra, and Marble Bar, no important mining centre in the State will have much to complain of as regards transport facilities. It is also worth bringing out that the State is a remarkably easy one for traversing with horses and vehicles, formed roads being hardly ever required. Cartage rates are often expensive owing to high cost of fodder and distances to be traversed, but there is rarely any physical difficulty in carrying goods to any part of the fields. The popular idea that our goldfields are wildernesses of sand requires to be combated on every opportunity. In reality the State is a particularly easy one for getting about from place to place, except for the great distances to be traversed.

Water supply is constantly being extended, and all the principal travelling routes throughout the State are fairly well supplied with

water. Great efforts are made by the Mines Water Supply Department to get wells in all districts where prospectors wish to work, and in many instances wells have been put down ahead of any serious prospecting.

An institution under Government control, which is bound to have an increasing beneficial influence on the mining industry of Western Australia, as time runs on, is the School of Mines, established at Kalgoorlie, for imparting scientific and technical instruction, and a thoroughly practical training in mining methods. Another public institution intimately associated with the gold production of the State is the branch of the Royal Mint, in the capital city of Perth, which is controlled by the Imperial Government, and is administered by a Deputy Master, directly responsible to that Government. Although, therefore, the Mint buildings, having been erected by the State are Colonial property, the working institution is an Imperial Department. Here the product of the goldfields is converted into standard English sovereigns and half-sovereigns, the Mint providing a market in the State, where the standard value of gold (£3 17s. 10½d., 11-12ths fine) can always be obtained for the metal, without delay, instead of the producer being compelled to make the best bargain he can with a bank, or with a private dealer, or having to send his consignment of gold over-seas for disposal.

The State of Western Australia pays an annuity of £22,500 towards the working expenses of the Mint. But as the whole of the receipts of the institution are paid into the State Treasury, and these far overtop the expenditure, the result is an annual substantial gain to the State.

I will now refer briefly to the minerals, other than gold, to be found in various parts of the huge area of Western Australia. Were it not for the overwhelming predominance of the gold-mining, these other minerals would, no doubt, attract more attention than they do at present. But, as it is, the extensive deposits of copper, tin, and coal are being worked to considerable advantage, with every promise of enlarged operations and increased profits as time runs on; while a beginning has been made with utilising the tantalite cre found on the tin-fields.

There may be immense possibilities in this little-known mineral, tantalum. It is very ductile and can be readily rolled and drawn out in threads. At present its principal use is for filaments in electric incandescent lamps; but seeing that a very insignificant proportion added to steel increases the hardness fourfold, it appears to me that there must be a future for it in connection with either armour plates or armour piercing projectiles.

There is a very interesting article upon tantalum in the *Revue Scientifique* of the 27th July last, by Paul Nicolardot, Captain of Artillery and Doctor of Science, in which he says:—

"Unattacked by acids, inoxidisable at the ordinary temperature, this metal may be considered as equal to gold or platinum in its power of resisting chemical agents. It presents over them the advantage of being hard and resisting, especially when it is slightly carburetted, and what is better still, of being much cheaper."

Again he quoted the following experiments of Herr Von Bolton:—

"When heating an ingot of tantalum to red heat it is possible under the action of pressure to transform it into a plate whose hardness after several hammerings and treatings becomes superior to that of the diamond. A sheet, a millimetre thick, subjected for three days and nights to the action of a drill set with diamonds turning at a speed of 5,000 revolutions per minute was only cut into to a depth of a quarter of a millimetre."

I thought the British Government would like to experiment with a material possessed of qualities such as these, and some time ago offered to present a cwt. for this purpose. The offer is still "receiving consideration."

The census of minerals to be found in the State forms a long list—gold, copper, iron, mica, coal, silver, aluminium, manganese, lead, tin, antimony, asbestos, graphite, cobalt, bismuth, and tantalum. Diamonds and other gem stones have also been found.

Copper-mining was the first mineral-raising industry established in Western Australia, the discovery of a cupriferous area having been made as far back as 1848. As yet copper-mining in Western Australia can in no sense be considered fully developed. It is widely distributed. Ores rich in copper are found from one end of the State to the other, from Kimberley in the north-west down to the Phillips River field in the south-west division and the Murchison and Mount Margaret districts to the eastward. The total production to the end of 1907 was of £700,000 value.

Silver is obtained as a by-product in the treatment of gold at the Mint, the total amount thus realised up to the end of last year being about 1,500,000 ounces, of the value of about £200,000.

Black tin is another commercial mineral produced in the State, the principal localities of the deposits being Green Bushes in the southern part of the South-Western Division and the Marble Bar district in the North-West. The deposits have been proved to be extensive; but they are not as yet worked nearly so thoroughly as they might be. Only some twenty miles from Port Hedland, in the North-West region, a very rich tin-field was recently discovered, which promises to become a busy centre of operations under the more favourable working conditions which will result from the opening-up of the district by the railway it has been decided to construct at a cost of some £700,000. 1907 had the largest production of tin ore of any year yet recorded.

The Government Geologist reports that the tin lodes in this locality are numerous, and occupy a considerable area of country.

Deposits of hydrous bituminous coal have been found on rivers' banks, both in the north and the south of the South-Western division; but the only seams being operated upon at present are those on the Collie river, where very large deposits of this mineral have been located scattered over a considerable area. The output for the year 1906 was 150,000 tons, an increase of 22,000 tons over previous year.

A few opals have been found near Coolgardie; but not in sufficient quantities to warrant this stone figuring on the list of the State's products.

Limestone and iron stone, both used for fluxing purposes in the smelters, were raised in various parts during last year.

The total area of Crown lands held under leases for purposes other than gold-mining in 1906 was 27,000 acres, and under gold-mining leases 30,000 acres, making a grand total of leased mining land of 57,000 acres. No gold-mining is now being carried on in the State on private property, and only two other mineral leases on private property, covering together fifty acres, were running in 1906.

According to the official returns for 1906 the grand total of men employed in mining in the State, including gold getting above ground and under ground, was 19,429, of which number 17,926 were employed in gold mines. And every one of these workers, from the manager down to the casual hand, is a white man, working under white conditions for a white man's wage in a white man's country.

I believe I am justified in declaring in the most positive terms that there is no mine manager in Western Australia and no Board of Directors of a Western Australian mine who would propose to substitute black or yellow labour for white. This, too, notwithstanding the fact that these mines pay the very highest rates of wages.

So much for the capitalist point of view. The workers' attitude may be safely assumed to be one of uncompromising hostility to coloured labour. In this connection the following extract from an article by a British M.P., representing the Labour interest, who recently visited Western Australia, may be quoted as apposite:—

"On the gold mines where the output runs close up to £2,000,000 a year, no coloured person is employed. Some of the mines have now reached a depth of 2,000 feet, but whether above or below ground only whites are employed. And the mines pay well, the profits in some cases exceeding cent. per cent. on the original capital. All the conditions are here—climate, hardness of rock to be mined, and depth—which exist in South Africa, and I believe that a Commissioner from the Press of South Africa who recently visited Koolgarlie admitted that, were the methods of working which obtain in Koolgarlie to be adopted in South Africa, the same good result might also be obtained there, even were Chinese and Zulu coolies abolished, and only white labour employed."

I know nothing of the South African conditions, and have no opinion to offer thereon, but I do know Australian conditions, and Australian miners, and I am certain that the employment of white labour exclusively in Australian mines can be fully justified, not only for political, but also for economic and social reasons.

As for the tale of Western Australia's gold production, it is told in figures that have arrested the attention of the world. At one end of the record is the insignificant year's output of a few score ounces, worth a few hundred pounds; at the other a single year's output of 2,000,000 ounces, valued at something like £8,000,000 sterling. And when the proceeds of the whole twenty-three years are totalled they give us 18,000,000 ounces of gold, valued at £78,000,000, upon which dividends aggregating £17,500,000 have been paid. This is the work, too, of a little British community of only a quarter of a million people.

In closing this brief and imperfect survey of the mining developments and prospects of Western Australia, I cannot help congratuting that country, and this country, too, upon the possession of one of the richest mineral terri-

tories in the world. I think Western Australia's 23 years' mining history proves this. The result of the first year's operations was the production of only 302 crude ounces yielding 270·17 fine ounces of the value of £1,114 12s. 2¼d. But that modest-looking record, set out with official exactitude, down to the odd 17 grains of gold and the odd farthing of value, has become historic in our part of the world. It is a record that marks the beginning of a new era in one of the largest, as it is destined to be one of the most prosperous and populous of the Empire's oversea dominions. It marks the beginning of a period of pioneering enterprise that has found rich reward, of high hopes that have been realised, of the unconquerable courage that faced danger and death on the sun-smitten plains; of the splendid capacity that planted gardens in a waterless waste, built cities in the places that our fathers deemed to be uninhabitable; and thrust the outposts of colonisation and civilisation into the far interior of a continent.

APPENDIX.

Gold Production to 31st December, 1907.

	Square Miles.	Ounces.
Ashburton	14,230	5,295
Broad Arrow	1,038	246,898
Coolgardie	11,702	1,197,352
Donnybrook	100	840
Dundas	11,430	334,733
East Coolgardie	810	9,660,639
East Murchison	25,447	762,235
Gasgoyne	5,313	733
Kimberley	33,833	26,274
Murchison	20,650	1,875,068
Mount Margaret	44,860	1,511,639
North Coolgardie	32,858	1,276,545
North-east Coolgardie	21,594	534,341
Pilbara	32,696	215,306
Peak Hill	24,732	187,374
Phillips River	5,572	29,394
West Pilbara	10,843	19,534
Yilgarn	13,685	406,382
Yalgoo	18,833	53,494
State generally	Outside of Goldfields.	19,711
		18,363,787

DISCUSSION.

The Chairman (Admiral Sir Frederick Bedford) was not sure whether it was quite proper for the Governor to initiate a discussion on his own State, and his remarks would, therefore, be few. The writer of the paper had very clearly stated the fact that the mineral resources of Western Australia were not yet half developed. He had been to all the goldfields, and in the Pilbarra district, to which Mr. Rason had called attention, it was impossible for the rich deposits to be properly developed until a railway was constructed. When he went up Port Hedland he saw machinery lying half covered with sand, which had been waiting for over six months for transportation. It had to be carried either by donkeys or camels, which were not convenient animals for the transport of boilers and other heavy weights, so that the process was exceedingly slow. When the railway was constructed a very large field of activity would probably be opened, and capital, which was very badly wanted, would be attracted. Occasionally the investing public in this country had their ardour damped because the Westralian mines had not always turned out as good as it was said they were; but at the present moment the gold-mining industry in most of the large mines in Western Australia was a settled one. At Kalgoorlie, they were working away just as if they were turning out cotton goods. The mines were worked in a regular and systematic manner, and had a new lease of life given them by the discovery of paying ore at great depths. Not long ago he went down to the bottom of the Boulder Mine, over 2,000 feet deep, and owing to the extraordinary improvements of modern machinery, paying ore at that depth was being obtained. Very low grade ore could be made to pay nowadays, while the employment of very expensive labour was also reduced as much as possible by the introduction of up-to-date machinery.

Sir John A. Cockburn, K.C.M.G., thought the hall of the Royal Society of Arts might be regarded as a centre for the dissemination of Imperial knowledge with regard to the resources of the Colonies. If a handy history of the development of His Majesty's dominions beyond the seas was required, it would be found in the archives of the Colonial Section of the Society as recorded in the *Journal*. It was not often, however, that such an interesting conjunction was seen as that of the representative of the Crown in Western Australia with the representative of the Government of Western Australia, in London, taking the leading part in an important London meeting. The Section accordingly welcomed his Excellency the Governor, who by his residence in the colony had taken years from his age instead of adding them, and afforded a splendid advertisement for the climate. The description of the development of the gold-mines in Western Australia sounded like a fairy tale, but Western Australia was in itself a fairyland. He remembered the time when it was the Cinderella of the Australian Colonies, and was described as the land of sand, sin, sorrow, sore eyes, and Sir John Forrest. Since then the wand of the fairy godmother had been waved over it; it had become the Golden West, and was a pride to the whole of the

Continent of Australia as well as to the Empire. Those who were occupied in the great centre of the world's finance, and complained that the currency was not sufficient for the growing requirements of trade, turned grateful eyes to the gold-producing areas of the Empire, because every ounce of gold turned out did something towards lessening those terrible fluctuations in prices which were due to the scarcity of the medium of currency. Everyone recognised that Western Australia afforded a signal instance of indomitable pluck, enterprise, and intelligence on the part of the British colonist. The wonderful feat of the construction of the waterworks which supplied the goldfields was a monument of that industry. Australia was to be congratulated that she had preserved that vast continent as a home for those of her own race, as a receptacle for all the traditions of the race, and as a stronghold for the reinforcement of the British power in that great arena of future international complications—the Pacific. Australian labour, although it was high priced was cheap; and on the authority of Professor Gregory, one of the best known geologists of the Empire, Australia held the record for cheap shaft sinking. In spite of the price paid for Australian labour, the amount per foot which it cost to sink a shaft was lower in Australia than any part of the world. Notwithstanding the somewhat tantalising attitude of the Government of this country, in the fact that it was not always alive to the great resources of the Empire, other parts of the world were quite awake to the great resources of Western Australia, which were not limited to the produce of the mines. He noticed recently that the value of Western Australian hard timbers, and eucalyptus timber generally, was being recognised by the United States, and that some of the great railway companies there were taking steps to provide their own supply of those valuable timbers by making huge plantations of the better sorts of hard wood. When one considered the lasting power of hard wood sleepers and pavement compared with that of pine wood and softer material, it was extraordinary that anything but Australian hard woods should be laid down for the pavements of the metropolis: it had always seemed to him a waste to lay the soft and perishable timbers which were used in the streets of London. The life of a soft wood sleeper was only seven years compared with the twenty years of a hard wood sleeper, in fact in Australia sleepers had been known to last forty years. It was always a pleasure to hear a paper by Mr. Rason, who was a business man, and who had done good service both as Agent-General and as Premier of Western Australia.

The Hon. J. G. JENKINS (Agent-General for South Australia) said that South Australia practically ran side by side with Western Australia for nearly 2,000 miles, and, speaking on behalf of the adjoining State, he desired to say that they were exceedingly pleased to hear of its prosperity. He had the privilege of visiting Western Australia during the time the great waterworks were declared open, and he remembered with gratification the kindness which was shown him by the author, who was at that time Minister of Works for Western Australia. The people of the Eastern States of Australia as well as the people in England looked upon Western Australia as entirely a mining community; but after visiting various parts of the State he found that even five years ago there were many people who had made their fortunes out of mining who were devoting their time and attention to agriculture and pastural pursuits. South Australia used to furnish Western Australia with its fruit, wheat, and eatables to a considerable extent; but now Western Australia was practically self-supporting as far as those products were concerned, and in addition was exporting its surplus to the London market. Although South Australia had lost that market, they were exceedingly pleased at Western Australia's prosperity, because it had inspired a greater energy, so far as South Australia was concerned, and the growers in that State were now exploiting the London and Continental markets. He mentioned those facts because he wished it to be distinctly understood that, although Australia was one of the greatest mineral countries in the world (and Western Australia produced half of the golden wealth of Australia) the permanency and stability of that continent did not entirely depend upon its mineral resources. Even after a lapse of twenty, thirty, or fifty years if the Western Australian mines worked out, the people who were now settled in the country working in conjunction with the mines would find ample opportunity of carrying on other productive industries without moving to new fields of operation. As far as Western Australia was concerned, the other States were pleased with its progress; and if only people would take the trouble to investigate the development of mining and agriculture in Australia during the last five years, they would come to the conclusion that there was no better part of the British Empire in which to invest their money if they were asked to do so.

The Hon. ALFRED DOBSON, C.M.G. (Agent-General for Tasmania) said the fact that his Excellency the Governor was presiding over the meeting reminded him of the tie that existed at present, and which he hoped would always exist, between the Mother Country and the Colonies in the custom of appointing an English Governor to the Dominions beyond the Seas. Nothing was more calculated to keep the people together. The Governor had come home on a well-earned holiday, and they were glad to know what a great success his administration had been. The previous speakers had referred to the fact that it was not merely the gold-mining industry which had made Western Australia an important country. If the author had had time, he could have given some interesting details with regard to the natural resources of the country other than minerals. At the present time there was a great shortage of timber

all over the world owing to its enormous use, America alone exhausting 100 square miles of timber per annum for the making of railway sleepers alone. His own colony of Tasmania was exporting timber to Europe, to all parts of Australia, to the East and to South Africa. He hoped the question of the conservation of the forests would be seriously taken up, and that the author would impress its necessity upon his own Government. Although at present there were vast areas of timber which seemed almost exhaustless, the time was fast coming when the practical need of forest conservation would be recognised. He was glad to hear Sir John Cockburn touch upon the fact that the greatest commercial centre of the world, London, was indebted to their friends in Australia, where the population was very sparse, for large supplies of gold during the last two or three years, not only in nuggets but in golden sovereigns, which had been brought to London to the extent of many millions, and which had no doubt operated to relieve the money market to a considerable extent. He desired to add his congratulations to the author, who made such an excellent Agent-General for Western Australia, for the paper he had given.

Mr. V. TRUBSHAWE said that, although he was delighted to hear that only white people were engaged in the mining industry in Western Australia, he thought the circumstances were different in South Africa, and necessitated the employment of coloured labour. The bodies of ore at Johannesburg were not quite so large nor so rich as those in Western Australia, and therefore, he did not think it was fair to draw a comparison between the two countries. There was no doubt that in South Africa cheap black labour was required. When one remembered the fact that in Africa there were about ten black men to every white man, it was almost necessary that ample black labour should be employed to enable the mines to pay. He was certain they could not be made to pay with white labour only.

The CHAIRMAN, in proposing a hearty vote of thanks to the author for his exceedingly interesting paper, said he was very pleased at the opportunity of doing so because he had known Mr. Rason both in his own State and also at home. In his own State, as Minister, he was closely associated with the great work of bringing the water to the goldfields from Mundaring, a work which had been of immense benefit to the mining industry. The water was not only carried over a distance of 360 miles, but was raised 1,500 feet, and was altogether a very wonderful work. Mr. Rason had not only done good work in his own State, but everyone in Western Australia recognised that he was doing good work for the State in England. The paper could not fail to be of great value in making the capabilities of Western Australia better known than they were at the present time. He desired also to tender his own thanks to the Society for allowing him to have the honour of presiding at the meeting.

The resolution of thanks was then put, and carried unanimously.

Mr. RASON, after acknowledging the cordial manner in which the vote of thanks had been received, said he was not surprised at the kind things which had been said by all the speakers, because he had become used to kindness at their hands, and he knew that Western Australia had a good friend in each of the Agent-Generals of the sister States. He desired to express to his chief and friend, his Excellency the Governor, his warm appreciation of his kindness in attending, and taking the chair; it was one more kindness added to the very many that he had already received at his hands.

The meeting then terminated.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 1st, 1908; MAJOR PHILIP CARDEW, R.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Hood, James N., Fintragh, Midmills-road, Inverness.
Humphreys-Davies, George, 7, Portsea-place, Connaught-square, W.
Leeson, J. H., St. Thomas's School, Howrah, India.
Morrison, Captain James, K.I.H., Nagpur, Central Provinces, India.
Nicholson, Sir Frederick Augustus, K.C.I.E., Yercaud, Madras Presidency, India.
Parcon, Raymond, F.R.G.S., Victoria-Mahé, Seychelles.
Wills, Henry Tarleton, Morley's Hotel, Trafalgar-square, W.C.
Wilson, James, C.S.I., Lahore, Punjab, India.

The following candidates were balloted for and duly elected members of the Society:—

Buckingham, Sir James, C.I.E., Lorrenden-lodge, Beddington, Croydon, Surrey.
Fairbairn, Rev. Principal A. M., D.D., LL.D., Mansfield College, Oxford.
Gower, R. Vaughan, Ferndale-lodge, Tunbridge Wells.
Meldon, Major James Austin, Windham Club, 13, St. James's-square, S.W.
Mody, Ardeshir S., 11A, Harrington-gardens, S.W.
Outram, Rev. Arthur, Little Heath Vicarage, Potters Bar, Herts.

Reinhold, Gustave C., Assoc.M.Inst.C.E., 11, Hervey-road, Blackheath, S.E.

Salahuddin, Khan Bahadur Kazi, Nandura Nemgaon. Buldana, District Berar, India.

Sharma, Pandit Umapatidatta, B.A., 1/1, College-square, P.O. Bowbazar, Calcutta, and Chilehri, P.O. Manjhawari, Arrah, India.

Shore, Joseph, J.P., Cinnamon-hill, Little River, Jamaica, British West Indies.

Trotter, Lieut.-Col. Sir Henry, K.C.M.G., C B., 17, Chester-square, S.W.

The SECRETARY announced that Sir William White, who was to have occupied the chair, had unfortunately been prevented from attending the meeting, to his extreme disappointment, he having been called away on rather important business. Sir William was leaving for America on the following Saturday, and as he was over-powered with work it had necessitated his giving up an engagement which he had looked forward to with much pleasure. He had, however, sent the following letter : —

8, Victoria-street, Westminster, S.W.,
1st April, 1908.

DEAR SIR HENRY WOOD,

Will you kindly convey to Mr. Wurl and the audience at the meeting to-night my regret that I am unable to take the chair, in consequence of unforeseen and unavoidable engagements ?

Had I been present, I should have expressed my thanks to Mr. Wurl, who undertook the duty, at my request, at a time when heavy professional work made the task very difficult. Having read the proof of his paper, it affords me much pleasure to add that Mr. Wurl has dealt with a most important subject in a manner which can be described as intelligible and comprehensive. Hearers who have only elementary mathematical knowledge will be able to follow his clear explanations of the principles underlying the rolling motions of ships in a seaway, and those relating to the steadying effect of gyroscopes fitted to ships on the system devised by Dr. Schlick. Scientific men will also find much of value and interest to them. The models used for illustrative purposes by the lecturer have been lent by Dr. Schlick, and have been previously used by him in demonstrations given before the German Emperor and the highest naval authorities of Germany.

My own connection with the matter began some years ago, and resulted from my long-standing friendship with the inventor. That must not prevent me, however, from placing on record once more my appreciation of the scientific knowledge and ability, as a mechanical engineer, which Dr. Schlick has displayed in the design of his apparatus ; while the courage he has shown in furnishing proof of the capabilities of the system by actual trials in the *Seebar*, has done much to secure its practical adoption. Due acknowledgment also should be made of assistance rendered by Herr Ballin, and the Hamburg-American Company, both in carrying out the *Seebar* trials, and in applying the system to the *Silvana*. Messrs. Swan, Hunter, and Wigham Richardson, on my recommendation, acquired the rights of the patentee for this and other countries. In their capable hands the system is certain to receive successful application and valuable development. Mr. Wurl himself, being actually engaged under that firm in the designing work of this apparatus, is rendering good service in alleviating the sufferings of over-sea passengers, and all that he says is based on complete knowledge of principles and results.

My own estimate of the value of the system has been given in a paper read before the Institution of Naval Architects, to which Mr. Wurl refers. In my judgment, the first and probably one of the most important applications, is that to passenger steamers of small size engaged on cross-Channel and coaling services. I do not doubt but that gyroscopic steadying apparatus might also have effect beneficially on larger ocean-going steamships; and it is possible that, in future, installations of that kind may be introduced. On the other hand, the large size and comparatively long period of rolling oscillations in large steamships themselves tend to remarkable steadiness under most conditions at sea. Consequently there is less reason for steadying apparatus which must, in large ships, be on a large and costly scale.

There are many minor applications possible of Dr. Schlick's system to particular items of equipment on board mercantile and warships. To these, detailed reference is unnecessary.

One most important point still requires to be investigated more fully than has hitherto been done. Mathematicians have attacked the problem of the design and determination of dimensions of the gyroscopic steadying apparatus required to produce certain desired results in ships of known dimensions, weights, and periods of oscillation. Dr. Schlick has called in the aid of German professors. Professor Perry and other English mathematicians have made similar investigations. My own conviction is that this is a case where mathematical analysis must be supplemented by actual experiment, before trustworthy rules for practice can be laid down. The *Seebar* trials are valuable, but necessarily limited in scale. The *Silvana* trials will add greatly to our stock of experimental information. Trials on British vessels about to be fitted by Messrs. Swan, Hunter, and Wigham Richardson will also assist a solution. The matter is yet in its early stages, but there is every reason to believe that it will receive great developments and prove a blessing to those who have "to do business in great waters."

Yours sincerely,

W. H. WHITE.

The paper read was—

DR. SCHLICK'S GYROSCOPIC APPARATUS FOR PREVENTING SHIPS FROM ROLLING.

By M. Wurl.

A vessel in a seaway is subject to periodical movements which may be divided into three classes, viz. :—

1. Heaving, *i.e.*, vertical up and down movement of the ship bodily.

2. Pitching, *i.e.*, swinging about a transverse axis so that the ends of the ship move up and down.

3. Rolling, *i.e.*, swinging about a longitudinal axis so that the sides of the ship move up and down.

All periodical movements are accompanied by forces of acceleration and retardation, whose effect upon the human organism is more or less unpleasant, and all the movements mentioned are therefore apt to cause sea-sickness more or less, in accordance with their character, their magnitude and their frequency.

Heaving motion is unavoidable with ships designed to float on the surface of the water and therewith on the surface of waves. Submarines are naturally less liable to heaving, as the wave motion decreases with the distance from the surface of the water, but compared with such a mode of travelling, probably heaving will appear as the smaller evil. The range of motion, according to the height of sea waves, is not unfrequently 20 feet, and sometimes may exceed even 30 feet, but fortunately the frequency or the period in such cases is not high, and with shorter periods the amplitudes are proportionately smaller, so that in either case the accelerating forces do not exceed certain limits. Furthermore, the pure heaving motion, with the decks keeping horizontal, seems to have comparatively little effect upon the human frame, and observations show that considerable amplitudes are satisfactorily borne by most people. This is, perhaps, the reason why heaving is so rarely mentioned as a cause of sea-sickness.

Pitching is considerably more dreaded, and the movement is undoubtedly most unpleasant at the ends of a vessel, considering that the period of pitching is generally very short, and one may be pitched over 30 feet up or down within two to three seconds. But pitching has the relieving feature that its effect can be evaded, almost entirely, by staying amidships, where the vertical movement due to pitching is naturally *nil*; the remaining angular movement does not often exceed 4 degrees to each side, and is, therefore, immaterial in comparison with rolling, where not unfrequently angles of five times that amount are recorded.

In rolling, two movements should be distinguished, viz., the vertical movement at the sides of the vessel, and the much more disagreeable angular movement which equally affects all parts of the ship, and therefore cannot be evaded. Small angles up to about 5 degrees to each side are of little consequence, but the effect of angles over 10 degrees or even 20 degrees, is not so easily forgotten; and people who have experienced real rolling of this description, who have felt the discomfort of moving about on board a ship when the level of the decks is changing incessantly from side to side, who have seen dishes, plates, vegetables, &c., sliding and rolling about the dining-table, and especially those people who have avoided altogether the sight of the dining-tables on such occasions, will not long for a similar experience. The general wish, under such conditions, is that the rolling should stop, and probably there is sometimes an indistinct hope that some mysterious power could appear and hold the ship steady. This power has now appeared with Dr. Schlick's invention of his gyroscope for preventing ships from rolling.

Prevention is to be distinguished from reduction of rolling. Various appliances have been devised for the latter purpose, so for instance the bilge keels, now almost generally applied, form a simple expedient for reducing rolling to some extent. But as their effect depends upon the water resistance set up against the rolling motion itself, considerable angles of roll must necessarily remain under all conditions, in order to produce an effect, and therefore nothing but a moderate reduction of rolling can be expected from bilge keels in practice. The same applies to rolling tanks and other appliances whose action depends upon the existence of large rolling angles.

To prevent rolling it has to be stopped at the root so to speak; and to understand fully how this is accomplished by Dr. Schlick's gyroscope we must first understand how rolling arises. Closely connected with this problem is the well-known fact that some vessels show a great tendency to rolling while others hardly ever roll at all.

A vessel in still water when forcibly heeled

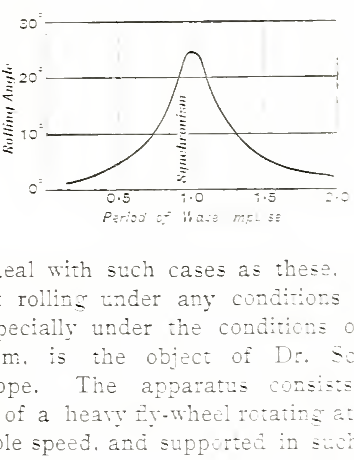
over and then suddenly released behaves like a pendulum, viz., carries out a number of oscillations about its upright position, which decrease gradually in their amplitude but succeed each other in equal intervals of time. This constant time interval, called the natural period of the vessel, depends to a great extent upon the metacentric height of the vessel, and is therefore a factor of the design, so that the naval architect is enabled to give the ship a long or a short period as may be required. The period is of great importance in a seaway in connection with the periodical movements forced upon the ship by the impulse of the waves.

The waves passing underneath a vessel tend to incline it so as to bring the decks in parallel with the effective wave slope. If the waves are met in quick succession, the movement actually taking place will be very small, from want of time. Further, if the waves are met very slowly, the ship will have time to follow the wave slope closely, and the maximum angle of roll will be equal to the maximum effective wave slope, which is generally moderate. Serious rolling is, however, almost certain, even in a comparatively light sea, when the waves are met at such regular intervals as correspond with the natural period of the vessel, or in other words, when synchronism exists between the period of the wave impulse and the natural period of the vessel. In such cases the rolling angle gradually becomes larger with each wave, the rolling is accumulative, and with perfect synchronism the angle would become infinite, *i.e.*, every ship would turn turtle if it did not encounter sufficient water and air resistance, which absorbed the energy added to the swinging vessel by every fresh wave impulse. Naval architects are paying due attention to this problem, and the factor of safety in modern ships is so great that cases of overturning through excessive rolling are almost unknown.

Nevertheless, the rolling angle accumulated at or near the period of synchronism is usually many times larger than the maximum effective wave slope producing it. To illustrate the relative tendency of a vessel towards rolling under the conditions mentioned, Fig. 1 has been prepared; it represents the maximum rolling angles which could be accumulated by waves, all of the same height but meeting the vessel at different time intervals or periods. The curve applies to an actual ship (*Seebär*), and has been derived from various observations; further investigations show that other vessels would yield curves more or less similar in character. Fig. 1 indicates that by far the greatest rolling angles occur at or near the period of synchronism, at higher or lower periods the angles become rapidly smaller. It is therefore obvious that rolling can be avoided, to a great extent, by avoiding synchronism.

The possibility of avoiding synchronous rolling was recognised many years ago, when observations had shown that the actual periods of wave impulse, generally met with at sea, are comparatively short and can be greatly exceeded by the ship's period, if the metacentric height is kept sufficiently small. But although this has been frequently pointed out by leading naval architects, there are still many ships afloat with too short a period, so that heavy rolling is frequent with them. Others are much less liable to roll, as mentioned above, and it is likely that further improvements can and will be made in this direction; yet, however long the period of a vessel may be, the chances of synchronism and therewith the chances of heavy rolling still exist, especially with a quarter sea.

FIG. 1.



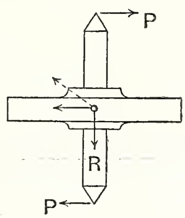
To deal with such cases as these, *i.e.*, to prevent rolling under any conditions of sea, but especially under the conditions of synchronism, is the object of Dr. Schlick's gyroscope. The apparatus consists principally of a heavy fly-wheel rotating at a considerable speed, and supported in such a way that any tendency of a wave to heel the vessel over sets up gyroscopic forces in the apparatus, which practically counterbalance, at every instance, the effort of the wave, and thus prevent the ship from rolling.

To avoid misunderstanding, it may be pointed out that these forces, set up in the apparatus, are active forces and must not be confounded with ordinary dead resistances, which would be offered by the ship, if it was kept absolutely rigid, as for instance on a rock. It must also be mentioned, that the steadying effect is not merely due to the presence of rotating masses, so for instance,

steam turbines in a vessel or even Schlick's apparatus under certain conditions, as will be shewn later, have not the slightest effect upon the rolling. To explain these and other phenomena, connected with the present problem, a brief investigation regarding the origin of gyroscopic forces will be necessary.

Suppose a wheel or disc (Fig. 2) be rotating so that the mass element or particle at the front side of the circumference moved towards the left, as shown by the full drawn arrow. The forces P P, tilting the axis of rotation, tend to bring the particle into a new direction of movement shown by the dotted arrow, and it is evident that the resistance offered by the particle against this change will be downwards as indicated. As the particle passes on, others will appear in its place, and the resistance, R, will consequently last as long as the tilting movement of the axis continues

FIG. 2.



in the indicated direction, P P. A similar consideration shows that the same tilting movement causes particles passing through the opposite position at the back of the circumference, to offer resistances upwards. Particles at both sides of the circumferences do not change their direction of movement and, therefore, offer no resistance against the tilting of the axis. Partly one and partly the other of the three conditions mentioned applies to all the intermediate mass particles, at the circumference of the disc as well as anywhere inside. All the front particles exert gyroscopic forces downwards, and all those in the back of the disc upwards, their combined effect being a resisting movement or couple whose axis is at right angles to the axis of the tilting movement, P P (compare Fig. 2). A strict mathematical investigation shows that this couple increases in direct proportion with the angular velocity of tilting, with the speed of rotation, and with the inertia moment of the rotating mass.

All these facts can be corroborated by experiment and some by observation in practice. So for instance, on a paddle steamer the following phenomena can be observed :—

1. If the course is suddenly changed, the vessel heels over.

2. If the vessel is heeled over, say, by a wave, the course is slightly altered.

These phenomena are largely due to the gyroscopic action of the paddle wheels, but, owing to the small rotary speed of these wheels, the effect is generally so slight that it is not easily noticed. To show these phenomena more clearly, this model (A) has been designed, in which the two paddle wheels are represented by solid discs revolved at a high speed by means of a small electric motor. The little vessel is so supported that it can heel over to either side and turn freely about a vertical axis. It is noticeable, with the wheels revolving, that a slight turning of the bows to starboard causes the vessel to heel over to port, and convertibly. Further, if the vessel is heeled over by a small weight added to one side, it starts to turn and alter its course ; for instance, by heeling over to starboard the ship's bow is turned to starboard. It is rather curious that this should take place in practice, as the starboard paddle would be deeper immersed, when the vessel is over to starboard, and would, therefore, tend to turn the vessel in the opposite direction, *i.e.*, to port. Yet the phenomenon was observed by Dr. Schlick some years ago and has induced him to a closer study of this problem and of gyroscopic problems generally ; the result of these studies was the invention of the gyroscope which forms the object of this paper.

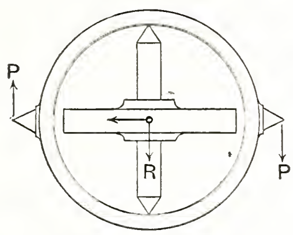
A further example for demonstrating gyroscopic forces is the portable gyroscope (B), consisting of a flyweel mounted in a circular frame ; when set spinning it can be moved about with its axis parallel, without offering any appreciable resistance ; but gyroscopic forces can be distinctly felt with this apparatus when holding it in two hands and producing the necessary tilting movement ; it can also be noticed that this strange resistance does not act in the direction of the movement, but in a plane at right angles to the intended tilting movement. This latter fact, which coincides with the preceding investigations, goes to show that a gyroscope like this, if fixed in a ship, could not resist any impulses of the waves, because the gyroscopic forces produced would always be at right angles to the forces of the waves, and could, therefore, have no steadying influence. The same argument applies to any other rotating mass on board a ship, as steam turbines, paddle wheels,

&c.; and no steadying power can be expected from these, because their axis of rotation is fixed in the ship, and therefore practically immoveable in certain directions.

That the effect is *nil* under these conditions, can easily be judged by the movement of this pendulum (model E), which has a gyroscope of the preceding type attached to it. The pendulum swings with a certain period when the fly-wheel is at rest, and the experiment shows that the movement is exactly the same after the fly-wheel has been set spinning. It is, therefore, evident that something more is required for creating those forces which are necessary for preventing ships from rolling.

Fig. 3 shows the fly-wheel placed in a frame, which is held in bearings at the right and left, so that it can swing about this horizontal axis. The forces, P P, acting now upon the frame, and tilting it in the direction indicated, create gyroscopic forces, R, as has been explained in connection with Fig. 2; viz., the forces, R, are directed downwards in the front parts of the wheel, and upwards in the back. The same rule applies, if we look at the wheel from the left-hand side, and assume that the frame be tilted by the forces, R. As the direction of the movement is in every way the same as in the previous case, the gyroscopic forces set up by the new tilting movement will again be downwards in front of us, that is at the left side of Fig. 3, and upwards at the opposite side, forces which are evidently both opposed to the original forces.

Fig. 3.



The arrangement shown in Fig. 3 is consequently able to oppose tilting or angular movements, as may be further demonstrated by our pendulum apparatus. It will be remembered that the swinging movement of this pendulum (model E), was not in any way modified by the gyroscope attached to it. The reason for this was that the gyroscope frame had been prevented from swinging and consequently from acting upon the pendulum, as will be obvious from the explanations given. If now the frame is released and left free to swing, it will be noticed that the same pendulum is very much slower in its period; because it is practically held steady in its extreme positions for a short interval of time, until the gyroscope has finished its full swinging movement of about 180 degrees, and therewith exhausted its resisting power.

It will further be noticed that, although the pendulum is retarded each time, and its period is thereby lengthened, the amplitude does not decrease, and consequently, if such a gyroscope was applied to a ship and any appreciable roll did appear, the apparatus would not be able to extinguish it. And naturally so, because the apparatus has no means yet for absorbing any of the energy contained in the vibrating system. To remedy this, Dr. Schlick applies brakes to the swinging movement of the gyroscope frame, and if the small friction brake of this pendulum apparatus is brought into action, the movement of the pendulum is quickly extinguished (Shown by experiment.)

There are consequently two outstanding features in Schlick's gyroscope, viz.:—(1) The general arrangement of the apparatus; and (2) the brakes.

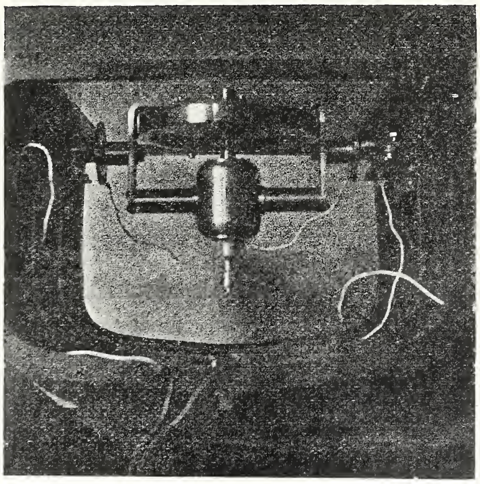
The general arrangement is shown diagramatically in Fig. 3. The axis of the fly-wheel may have any position transversely to the ship, but provision must be made that it automatically returns to this position, in order to produce the best results. The axis of the oscillating frame is also placed transversely in the ship, but at right angles to the above normal position of the fly-wheel axis, whose ends move in the fore and aft direction when the frame is swinging. These conditions are fulfilled in the two pendulum models here exhibited, whose vibrations may represent the rolling motion of a vessel. In one of the pendulums (C) the axis of the fly-wheel is originally vertical; in the other (D) it is horizontal, and the experiment shows that both gyroscopes behave in a similar manner, and increase the period of the pendulum equally well. But preference is generally given to the arrangement (C) because the forces of gravity can here be employed for returning the fly-wheel axis to its original position, which simplifies the design.

As mentioned above, the brakes form another important feature of Schlick's apparatus and cannot be dispensed with. The small models exhibited here, viz., the gyroscope fitted in the

small vessel which is floating in the tank (E) and the other apparatus (F) (Fig. 4) applied to section of a vessel, have both friction brakes, which are always in action, and therefore readily extinguish any angle of heel given to the models in question. For larger machines the brakes are more elaborate, they are either hydraulic or friction brakes, and generally so designed as to meet the varying conditions of sea automatically, and to safeguard the gyroscope apparatus against overloading.

This model (F) further shows that the gyroscope offers no resistance against rolling, if the frame is tilted so far, that the axis of the fly-wheel becomes horizontal. This is due to the obvious fact that in this position, viz., with the fly-wheel axis in the fore and aft

Fig. 4.



direction, no resisting couples can be transmitted through the axis in the direction of rolling. The resistances are necessarily vertical to the fly-wheel axis and, therefore, only a component of these resistances, is useful in preventing rolling; at 90° deflection of the gyroscope frame the component becomes zero, as already explained. Should the frame swing further than 90°, the tendency of the apparatus would be again to prevent rolling, and even an overturning of the gyroscope as shown by this model, F, would not reverse its action. Practical considerations, however, lead to the adoption of a limit for the swinging motion, and stops are generally provided to arrest the frame, before an angle of 90° to each side is reached; such stops are existing at angles of 45° in the small tank model, E, before us.

Another appliance generally fitted is a brake, or other suitable device, for holding the gyroscope frame in a fixed position, and thereby suspending the action of the apparatus, even with the wheel rotating, as previously explained. Both the models before us, E and F, have such appliances, and the experiment shows that, with the apparatus thus put out of action, considerable rolling angles can be quickly accumulated by applying a comparatively small weight excentrically in regular intervals, as would correspond with the action of synchronous waves. But when the apparatus is put into action by removing the clutch that holds the frame, and the same weights are applied in similar intervals as before, the vessel remains practically steady, the residuary angle of roll required for the working of the apparatus being hardly perceptible, and only the gyroscope is seen swinging to and fro. This is very similar to the working of larger gyroscopes on board a ship at sea, and careful investigations have shown that a properly designed apparatus is able to adjust its movements so quickly, that equilibrium with any external moment is generally established within the fraction of a second, and all the irregularities of the wave impulses are followed by the machine with an astounding accuracy. It is therefore perfectly certain that rolling can be practically prevented by a well-designed apparatus of sufficient size.

What size the apparatus ought to be for a certain size of vessel, under the conditions of sea met with in practice, has been early recognised by Dr. Schlick as the vital question of his invention. He also realised that only experiments on a large scale could bring this problem nearer to its solution. He therefore purchased a suitable vessel, a German torpedo boat, and fitted it out with a gyroscope of comparatively large size. The steamer is 117 ft. long, 12 ft. 6 in. broad, and displaces 65 tons on a draft of 3 ft. 10 in., the metacentric height is 1·3 ft., and the natural period of rolling about 2·1 seconds from side to side. The gyroscope wheel is driven by steam, turbine blades being fixed on its circumference. The frame of the gyroscope is represented by the steam-tight cast-iron casing, receiving and exhausting the steam through the trunnions on which the gyroscope oscillates. The diameter of the steel fly-wheel is about 39 in., and its usual speed of rotation about 1,600 revolutions per minute. The hydraulic brake for controlling the oscillatory movement of the frame consists of a cylinder with a piston forcing the fluid through

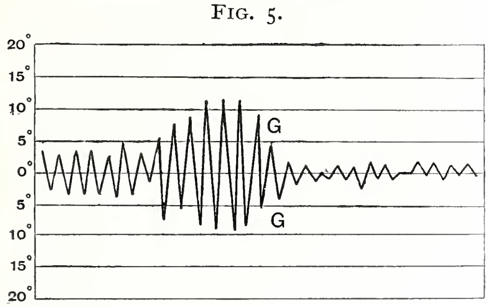
a valve, the opening of which can be regulated from deck. The arrangement for putting the apparatus out of action consists of a friction band brake, also operated from deck, by which the gyroscope frame or casing can be held in a fixed position or released as may be required.

The experiments carried out with this apparatus by Dr. Schlick yielded most satisfactory results, and it was found that the vessel could be kept steady in a sea, which produced rolling angles up to 20° to each side with the apparatus out of action. Fuller details of these trials are given in a paper read by Sir William H. White before the Institution of Naval Architects in 1907.

The success of these experiments has induced Messrs. Swan, Hunter, and Wigham Richardson, Ltd., of Wallsend and Walkeron Tyne, to acquire from Dr. Schlick the patent rights for the British Isles, France, and America, including the experimental vessel *Seebär*, which is now generally called *Seebar*.

Further trials have been carried out with this vessel recently off the Tyne, in the open sea. Dr. Schlick's experiments were made in the lower Elbe, and his greatest cause of complaint and disappointment used to be that the surface of the water was generally not sufficiently rough for the intended rolling trials. Such disappointments were hardly ever met with in the experiments off the Tyne, and even in moderate weather the sea was rough enough to toss the *Seebar* about violently. But the

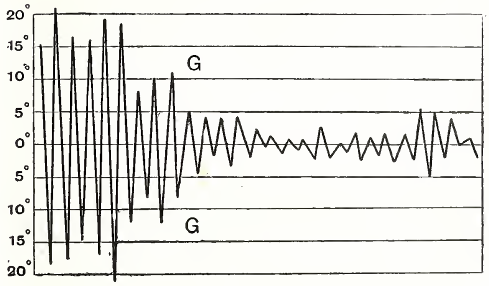
FIG. 5.



drawback was that the waves were generally so irregular in length that the condition of synchronism could seldom be far enough approached for accumulating a large rolling angle without, and thus the apparatus could not be shown to its best advantage. Nevertheless, the steadying effect was marked under all conditions of sea met with, and could be felt distinctly by everybody on board; so that the visitors who witnessed some of these tests, viz., representatives of various steamship companies and others, were generally convinced within a few minutes that by turning a certain wheel on deck, and thereby putting the gyroscope into action, the rolling could be stopped almost immediately, and further rolling could be prevented until the same wheel was turned in the opposite direction and thereby the action of the gyroscope again suspended.

Some of the results obtained during the various trials are reproduced in Figs. 5 and 6,

FIG. 6.



showing the consecutive rolling angles to port and starboard. The left-hand part of the diagrams represents the rolling observed without the gyroscope in action; at G the gyroscope frame was released and the apparatus began to act, with the results indicated in the diagrams. A small angle must necessarily remain to overcome the initial friction of the apparatus, this angle is as a rule negligeable, as in Fig. 5, and we may say that rolling is practically prevented as long as the gyroscope is in action. The diagram, Fig. 6, has been obtained in a much higher sea with occasional very steep waves, which have evidently not been fully mastered by the apparatus, as on one occasion the remaining angle of roll exceeds five degrees to one side; however the result may still be called satisfactory.

The experiments have shown that the *Seebar* is kept sufficiently steady when either drifting or steaming in a sea of about five feet average height, with occasional waves up to eight feet high. This result is very encouraging with regard to the application of gyroscopes to larger vessels working in comparatively longer and higher waves, and it may be reasonably expected that a wheel about 6 feet in diameter, running at 1,400 revolutions per minute, would keep a vessel of 2,000 tons displacement, with a moderate metacentric height, steady in any sea that is likely to be encountered. The metacentric height is of first importance, as the

size of the machine increases very much with this item. In steam yachts, pleasure and Channel steamers, which come principally in question for the application of gyroscopes, the metacentric height can be kept small, and, in any well-designed vessel, is kept as small as possible, on account of the advantages pointed out above, but there seem to be still many ships afloat where not enough attention has been paid to this important matter.

The first practical application of Schlick's gyroscope will be made in Germany. The Vulcan Works in Stettin have recently finished the apparatus indended for the Hamburg America Company's vessel *Silvana*, a pleasure steamer of about 900 tons displacement. This gyroscope is steam-driven and similar in design to that on the *Seebar*; the fly-wheel is 63 inches in diameter, and designed to run 1,800 revolutions per minute. The shop tests carried out with this machine a few weeks ago have given entire satisfaction, and the apparatus will begin its duty at sea very shortly.

The Tyneside Company have also commenced the manufacture of Schlick's gyroscopes at their Neptune Works. The design of their machines is somewhat different from the above. The fly-wheel is driven by an electric motor fitted on the same shaft. The brakes are not hydraulic, but friction brakes of a special design, and various other modifications have been introduced in order to produce standard machines of a compact, simple, and efficient type.

One apparatus for a pleasure steamer of 500 tons displacement is now nearly completed, and it is expected that, in Great Britain as well as in Germany, ships fitted with steadying apparatus will be in service very shortly.

APPENDIX.

LIST OF MODELS SHOWN DURING THE LECTURE.

(*a.*) A model of a boat (about 4ft. long) to show the gyroscopic effect of paddle wheels. These are represented in the model by solid discs driven by a small electric motor on the same shaft. The model is free to heel over to either side and is resting on a platform which can be turned about a central vertical pivot with very little friction.

(*b.*) A portable gyroscope, consisting of a fly-wheel carried in a frame.

(*c.*) A pendulum, consisting of steel rod and weight, with a gyroscope attached above the point of suspension. The latter consists of a frame which can swing about a horizontal axis, and carries the fly-wheel. The frame is weighted, so that it tends to keep the axis of the wheel in the plane of the pendulum, and therefore vertical. The movement of the frame can be arrested by a clutch, or retarded by a small friction brake, consisting of a spring.

(*d.*) Pendulum apparatus, similar to (*c*), but the gyroscope is attached so that its frame can swing, not about a horizontal, but about a vertical axis, and springs are applied, tending to keep the axis of the fly-wheel in the plane of the pendulum; there is no brake on this gyroscope.

(*e.*) A small boat (about three feet long) floating in a tank, and fitted with the usual type of Schlick's gyroscope (as under *c*), the fly-wheel, about five inches in diameter, is electrically driven; a clutch for arresting the frame, and a friction brake are provided as under (*c*).

(*f.*) A gyroscope apparatus of the same type (Fig. 4), but larger wheel (about twelve inches in diameter) fitted in a section of a vessel supported like a cradle. The wheel is also driven by an electric motor, running about 2,500 revolutions per minute; arresting clutch and friction brake are provided.

DISCUSSION.

The CHAIRMAN (Major Phillip Cardew, R.E.) thought the curves the author had shown, indicating that the oscillation of a vessel was reduced in a very remarkable way, must have convinced everyone that there was something practical in this application of the gyroscope. The apparatus was by no means large and cumbersome compared with the size of the vessel, and it therefore did not take up much valuable space. To look at, the gyroscope was an uncanny thing, giving one the idea that it was alive, and although the ordinary merchant skipper might at first have a certain reluctance to admitting such a wild beast into his ship, no doubt in time he would be convinced of its utility. As a director of a shipping company, engaged, among other things, in cross-Channel traffic, he had listened to the admirable paper with much interest.

Professor W. C. UNWIN, F.R.S., said the gyroscope was a little out of his particular path of work, and he therefore could only express his very great admiration for the labour Dr. Schlick had performed in perfecting the arrangement described. At first the gyroscope did not seem a very hopeful means of getting rid of large oscillations in heavy and big ships, and the fact that it had turned out that it could be used in a very moderate space, and only weigh a moderate amount, was a very remarkable result indeed; while the use of the brakes to bring the gyroscope to bear in its steadying action was also a very beautiful mechanical application.

Captain H. ACTON BLAKE inquired whether the author had noticed, in the practical experiments

carried out on the *Seebar*, whether retarding the action detracted, in some sense, from the seagoing qualities of the vessel. It would be interesting to know whether the action of the gyroscope, in not allowing the ship to swing with the actual motion of the waves, thus giving it a greater stability, and doing away with the mobility, did not tend to make the ship become a rock in the water. As a practical seaman, he knew that when a ship was very deeply laden and was too stiff she was not a good sea boat, it being necessary to have a certain amount of movement to obtain that quality. He understood the gyroscope did nothing but retard the rolling motion, and that it did not do away with the pitching motion of the ship; and, in his opinion, if the rolling motion was checked too much, it was likely to be detrimental to the vessel itself.

Admiral FITZGERALD said, as a practical seaman, he thought there could be no question of the efficacy of the gyroscope in stopping a ship from rolling; but he thought the size of the wheel would prevent its application in ordinary vessels. Perhaps, however, the wheel had been increased in size in the model simply for the sake of illustration. In consonance with the last speaker, he thought before it was applied, either for stopping the rolling of passenger ships, which was very desirable, or for giving a steady gun platform for big guns, which was also equally desirable, it would be well to consider what its effects on the sea-going qualities of the ship were. He had had fifty years experience of the sea, and had no doubt that the gyroscope was excellent for stopping periodic rolling, from what seamen called a ground swell, when each wave was practically of the same length and the ship set up a pendulum motion, *i.e.*, when the waves corresponded with the period of the ship. That motion became very distressing at times, but it had already been largely obviated by the placing of bilge keels on large ships, which almost entirely extinguished the periodic pendulum rolling. If the gyroscope was to be applied under the ordinary circumstances at sea, when the waves were not generally periodic, but of unequal length, if the ship was stopped, for instance, from rolling in a beam sea, the next wave would come on board and swamp her. It might almost be said that the rolling was provided by Nature to save the ship. As the advancing crest of the wave came along, the vessel heeled over, and the wave washed up her side; but it seemed to him that the gyroscope would tend to make the ship roll to windward, the danger of which every seaman knew, because of the swamping which was liable to take place. Therefore, although he admired the cleverness of the apparatus, he suggested it had better be tried at sea before it was put into passenger vessels.

Mr. A. C. BROWN inquired whether the author had ever tried any means of reinforcing the righting pressure of the gyroscope by other means, *i.e.*, whether he had ever used the gyroscope in miniature, and caused it to bring into action larger forces, such as the pressure of a jet of water forced into the sea on the proper side every time the vessel attempted to roll; because it seemed to him that would be a means of keeping the gyroscope very much smaller than could be done if gyroscopic forces alone were used to right a ship. He mentioned the point, because he was very much struck some time ago, when investigating the subject, to notice what a large amount of power was put into a good sized ship by each wave. One large wave would perhaps put 2,000 foot tons of energy into the ship, throwing her over in one direction. That was a very large knock for each swing; and if the swing coincided with the pendulum rate of the vessel, very few such waves would take an enormous amount of energy to restore the ship to equilibrium again. It therefore seemed to him that if the gyroscope, instead of being used to right the ship, could make an electric contact which would bring other forces into action, much greater righting forces would be brought to bear than a gyroscope could bring in from its own gyroscopic action.

Mr. L. CALISCH inquired whether the stopping of the rolling motion did not introduce a strain on the ship. He also desired to ask whether experiments had been made for the purpose of applying the gyroscope to aerial navigation, because, as the apparatus gave stability, he thought its greatest application would be in the design of aeroplanes, provided it could be designed light enough.

Mr. F. W. HODGES, in connection with the previous speaker's remarks with regard to local strains being set up in ships by the gyroscope, asked if any experiments had been made to prove whether more than one gyroscope could be applied to the same ship in parallel.

Mr. R. A. BRUCE asked whether, in the observations the author made with regard to rolling, any attempt was also made to gauge the amount of pitching that took place. It was perfectly obvious from what had been said that the gyroscopic forces were such that they converted a tendency to heel into a tendency to pitch. The resisting forces were taken on a hydraulic cylinder or a friction brake, which merely transferred the couple in the transverse plane into a couple in a longitudinal plane. It seemed to him it might be exceedingly awkward if it happened that the period of rolling which was extinguished coincided, either directly, or with some submultiple of the period of the pitching. The pitching might in that way be actually increased to a considerable extent in the extinguishing of the rolling. People who were engaged in the problem of flight, were anxious to apply gyroscopic stability apparatus to their schemes for conquering the air, but it was just

as well to point out that the same factor was always present, because at the same time that a force was extinguished in one direction, a force in a transverse direction was created.

Mr. WURL, in reply, said that all the experiments made were conducted by himself, and the observations showed that in keeping the ship steady, with the gyroscope in action, there was no swamping of the decks. The tendency to swamp the decks was far greater when a ship rolled, because the angle of the roll was so great that the ship nearly dipped into the water on both sides. He did not think the gyroscope put any greater strain on a ship than if the ship had an angle of roll of 25 degrees. It must always be remembered that the ship was not prevented from heaving, because if that was done the water was bound to come on board. Reinforcing the action of the gyroscope had not been tried as it was too complicated and he doubted whether reactive forces could be created stronger than gyroscopic forces in an equally small space. He agreed with the remark made that the application of the gyroscope to the aeroplane would be difficult, on account of the forces which were set up in the other direction. A ship was a stable system, while the aeroplane was very often unstable, and had a tendency to upset altogether. The Schlick gyroscope was only able to steady a stable system, and could only be applied to that purpose. One of the features of Dr. Schlick's scheme and patents was the use of more than one apparatus if the ships were large. He did not think additional strengthening would be required in a ship except in special cases; for instance, if the apparatus was put high up in the between decks. If it was placed down below, on the double bottom, no extra strength was required, for the simple reason that every apparatus was so designed that it could not exert a larger righting moment than what it was built for, and this moment was small in comparison with other moments and forces acting upon the ship in a seaway. It was quite true that the forces set up in the longitudinal direction by the resistance of the brakes would influence the pitching, but in following out the calculations with regard to the amount of those forces, it would be found that the resistance in the brake was very small compared with the resistance of the gyroscope itself. Furthermore, the resistance of the ship against the pitching motion was so enormous, that the practical effect on the pitching was absolutely negligible. Accurate measurements were not made of that nature during the experiments; but when the gyroscope was working, the pitching was not felt very much in the saloon, and even bottles on the table were perfectly steady. The effect was exactly the same whether the sea was a beam sea or a following sea; in fact, the course was generally selected so as to obtain the most rolling, in order to test the apparatus under the most severe conditions.

The CHAIRMAN, in proposing a hearty vote of thanks to Mr. Wurl for his interesting paper, said it must always be remembered that the rolling which had to be overcome was a cumulative action. It was not an individual wave that produced it, nor was it an individual effort of the gyroscope that overcame it, but the two things were both cumulative, and the effect was produced by comparatively small efforts directed at the right moment.

The resolution of thanks having been carried unanimously, the meeting terminated.

THE MINERAL PRODUCTS OF INDIA.

A paper in the December number of the "Records of the Geological Survey of India," lately pubished in Calcutta, contains some interesting information regarding the production of minerals in India. The author, Mr. T. H. Holland, F.R.S., director of the Geological Survey of India, gives the following Table of the total value of minerals for which returns are available for 1905 and 1906:—

	1905. £		1906. £
Gold	2,416,971	..	2,230,284
Coal	1,413,443	..	1,912,042
Petroleum	604,203	..	574,238
Salt	441,392	..	420,901
Saltpetre	235,723	..	270,547
Manganese ore	248,309	..	435,268
Mica	142,008	..	259,544
Ruby, sapphire and spinel	88,340	..	96,867
Jadestone	45,474	..	64,433
Graphite	16,890	..	10,009
Iron ore	13,827	..	11,341
Tin ore	9,917	..	13,799
Chromite	3,482	..	7,188
Diamonds	2,474	..	5,160
Magnesia	550	..	488
Amber	945	..	709
	£5,689,948		£6,312,818

As to coal, the production showed extended activity, the rise being from 8,417,739 tons to 9,783,250 tons, while owing to the rise in prices the total value, as seen in the Table, showed still higher figures. The Gondwana fields in Bengal are the principal contributors, while as regards the external demand the reduction of Japanese supplies has permitted a sensible increase of the exports to Singapore. The total quantity exported during 1906 for the first time exceeded a million tons.

The diamonds obtained in Central Indian States of Panna, Charkhari, and Ajalgarh during 1906 were valued at £5,160 which is a marked improvement on the values reported for previous years, the principal increase being in the State of Panna.

The same year marks the first interruption in the

increase of gold production in Mysore, the total value of the output having fallen below that of the 1905 by nearly £200,000. In graphite the outturn was 2,600 tons as against 2,324 tons in 1905. The production of iron ore during 1906 was only 74,106 tons against 102,527 tons in 1905, and 71,608 tons in 1904. The output is dominated by the quantity raised for the Barakar iron works, which is the only institution smelting on European lines. In regard to small native furnaces in the Central Provinces, there was a marked increase.

Jade is mainly obtained from the Myitkyina district in Burma, where the quarries yielded a diminished out-turn owing to a scarcity of labour. The trade in Rangoon, however, showed increase owing to the rise in the exports. Passing by magnesite, which shows a decreased output of no particular significance, it may be noted that the most conspicuous increase in production during the past year was in manganese ore, the total returned for 1906 being 495,730 tons against 253,896 tons in 1905 and only 150,297 in 1904, the heavy production being of course due to the maintenance of high prices in Europe and America. Most of the ore comes from the Central Provinces. Mica largely developed in quantity though not quite to the same extent in value. In the production of petroleum there was a slight drop in 1906, as compared with 1905, but a considerable increase as compared with 1904.

The agreement made between the Burma Oil Company and the producers in the Dutch East Indies has tended to reduce the figures both for imports of foreign kerosene and for export of Burma oil, although the figures for the former are largely affected by the failure of Russian supplies. From the same province are derived the rubies, reported by the Burma Ruby Mines Company as having attained (together with small quantities of sapphires and spinels) a total value of £95,540, as against £88,340 in 1905. During the year the Kashmir sapphire mines were again worked to about equal extent yielding a value of £1,327.

There was an unimportant reduction in the quantity of salt produced. In the rock-salt mines of the Punjab there was greater activity, and in addition to an increased output, the extension of tunnels has proved persistence of the two principal seams considerably beyond the area previously known with certainty. With regard to the quantity and value of imported salt, there was an increase in each in 1906.

The value of the saltpetre industry is gauged most uniformly by the figures for exports. The returns for the past five years indicate a gradual rise in the average value, but the industry shows no signs of real expansion. The exports average about 370,936 tons, mostly derived from Behar. Tin-ore has been produced in considerably Increased quantities in South Burma, where a special survey of the tin-mining industry is being carried out by an officer of the Geological Survey. There are also small mines in the Mergin and Tarry districts.

HOME INDUSTRIES.

Port of London Bill.—At last it would seem as if there is a fair prospect of reorganising the Port of London. The question is one of long standing, and has presented great difficulties owing to the variety and importance of the interests, often conflicting, concerned. As far back as 1902 a Royal Commission reported upon the administration of the Port and urged very radical changes if London was to retain its pre-eminent position as a port. And long before the Royal Commission was appointed, discussion was acute. In 1903 the Government of the day brought in a Bill, but it was not passed, and it has been left to the present President of the Board of Trade to take the first practical steps in the direction of reorganisation. Negotiations between the Government and the London and India Docks Company have resulted in the basis of an agreement, and negotiations are proceeding with the Surrey Commercial and Millwall Docks which it is hoped will result in an agreement. Before the present number of the *Journal* appears the President of the Board of Trade will have introduced his Bill for the acquisition of the docks and the reorganisation of the Port of London, and as it is to be brought in under the "Ten Minutes Rule," it may be taken that its main principles are not considered controversial. The Government have largely adopted the proposals of the Royal Commission. The Commissioners recommended *inter alia* (1) That a new port authority should be created to take over the powers and duties of the Thames Conservancy, of the Watermen's Company, and of the Trinity House so far as the duties and powers of the Trinity House related to the Port of London. (2) That the new authority should purchase the undertakings of the London and India, the Surrey Commercial, and Millwall Companies, subject to the obligation to lease or sell the warehouses belonging to the companies as soon as that could conveniently be done. (3) That the new authority should carry out extensive works in connection with the deepening of the river channels and with the improvement of the existing dock accommodation, and the provision of further dock accommodation, the expenditure on these several works being estimated at £7,000,000. (4) That the London County Council and the City Corporation should between them accept the financial responsibility recommended. The former body declined, and its refusal had a good deal to do with the late Government dropping the matter. It is understood that the new Bill proceeds on the broad lines of the suggestions of the Royal Commissioners, but its text must be awaited before the details as to the constitution of the Port Authority are known. It is, however, known that the Authority is to be made a self-supporting one, and as it will have additional revenue-raising powers given to it, there should be no difficulty in raising the revenue required to make it self-supporting. The present Debenture Stocks of the London and India Docks Company are to be exchanged for "A" Stock of the new

Port Authority, and their interest will be preserved intact, whilst their security will be improved. The existing "A" and "B" Preference and the Preferred Ordinary of the Docks will receive equal amounts of the new "B" Stock of the Port Authority, and the Deferred is to receive £75 "B" Stock for each existing £100, so that it will be practically guaranteed 3 per cent. dividend, or about 6s. per cent. more than the average earned by it since the amalgamation of 1901. Whether the Bill will go through is, of course, another matter.

Cotton Mill Building.—The *Statist* gives some interesting figures relating to the Lancashire cotton spinning mill building boom of the last five years. The boom began at the opening of 1903, and continued until the beginning of the present year. In 1903, nine mill companies were formed with an aggregate capital of £740,000 to provide about 746,000 spindles. The following year the number rose to 15 companies and 1,450,000 spindles. 1905 was a record year, 40 mill companies being formed with a capital of £3,350,000, and approximately 3,529,000 spindles. In 1906 the number of new mills fell to 22, with 1,840,000 additional spindles. Last year nearly equalled 1905, no fewer than 39 new mill companies being formed to provide 3,342,000 spindles. This year five new companies have been announced, but it is not expected that many others will be floated during the year. Taking the five years £10,695,000 capital has been put up, and 11,267,000 spindles. The new mills do not seem to have affected profits; on the contrary, notwithstanding a greatly increased producing capacity, 1907 was the most prosperous year known in the trade. According to a high Oldham authority the limited spinning companies who issue balance-sheets exceed in 1905 20 per cent. on their capital, in 1906 16 per cent., and in 1907 33·93 per cent. Dividends have averaged 11·26 per cent., and of capital there has been retained 5·58 per cent.

Electricity in Factories.—A good deal of opposition is being shown to the draft regulations suggested by the Home Office for the users of electricity in factories and workshops. The extent of the alleged danger to the safety of workpeople and others is held to be insufficient to justify the imposition of rules that would necessitate increased expenditure on the part of users of electricity. It is contended that the regulations as drafted would entail heavy outlay by struggling industrial concerns that have been employing thousands of men for years without having to record a single electrical accident, and it is urged that the regulations would act as a deterrent to factory owners when contemplating the electrification of their works.

The Sale of Camphor.—Since the camphor industry became a monopoly of Japan nine years ago, a British firm has acted as sole selling agent, but its agreement terminated on March 31, and it is understood that in future the Japanese Government will conduct the sales through Japanese Commissioners in London, Paris, Berlin, and New York. The Japanese Government has been moved to this change by a desire to get into closer touch with camphor buyers. The outlook for camphor does not improve. Not only has Japan to reckon with increased production of camphor in China; synthetic camphor is becoming a formidable competitor, and the Japanese Commissioners are likely to find it difficult to maintain present prices, which are only about half what they were a few years ago.

Foreign Parcels' Post Rates.—Last week the Associated Chambers of Commerce passed a resolution in favour of a revision of our foreign parcels' post rates, and Mr. Oscar S. Hall has compiled a table of comparisons of English and German rates from the official post-office guides which demonstrates the need for this revision. Usually the German rate is the same for parcels of 3, 7, or 11 lbs. weight, whereas the British rates vary with the weight. Mr. Hall shows that in nearly every case postage on an 11 lb. parcel from Germany is less than on a 3 lb. or 7 lb. parcel from the United Kingdom. Thus, to Belgium, Denmark, Holland, or Switzerland, the German rate for a parcel of 11 lbs. is 10d., the English rates to the same countries being 2s. for 11 lb., 1s. 6d. for 7 lb., and 1s. for 3 lb. To Norway the German rate for 11 lb. is 1s., to Austria 6d., to France 10d., to the United Kingdom, Italy, Roumania, and Russia 1s. 3d., to Servia 1s. 3d., to Sweden or Greece 1s. 7d., and to Portugal and Egypt 1s. 10d.; whereas a parcel of the same weight sent from England would cost 2s. to Germany or Norway, 2s. 2d. to France, 2s. 6d. to Austria, Sweden, Switzerland, Italy, or Portugal, 2s. 9d. to Servia, and 3s. to Roumania, Russia, or Egypt. Out of all these cases there are only three in which the British rate for a 3s. lb. parcel is less than the German rate for a 11s. lb. parcel, and there is not one case in which it is not cheaper to send 11s. lb. from Germany than 7s. lb from England. To the more distant countries the comparison is a little more favourable to us for the smaller parcels only. It may be that the German Post Office carries on its parcels post at a loss, and Germany is more favourably situated than England for the cheap transport of parcels to her immediate neighbours; but whatever the explanation of the disparity, it is obvious that our export trade by parcel post, amounting now in value to between four and five millions sterling per annum, is severely handicapped in so far as it is in competition with the similar export trade of Germany.

OBITUARY.

Colonel H. F. Swan, C.B.—Henry Frederick Swan, High Sheriff of Northumberland, and Hon. Colonel 2nd V.B. Northumberland Fusiliers, died at his residence, Prudhoe-hall, on the 25th ult. He was born at Walker-on-Tyne, 10th September, 1842, and

was apprenticed as a shipbuilder with the then firm of Charles Mitchell and Co. He represented the firm at St. Petersburg in 1862, and superintended the construction of a number of war vessels for the Russian Government. This work completed, the late Dr. Mitchell, as head of the firm, and Mr. Swan were each presented with a gold snuff-box set with diamonds. On the amalgamation of the firm of Mitchell and Co. with that of Sir W. G. Armstrong and Co., Elswick, in 1882, Mr. Swan became one of the directors of the newly-formed company, and he had continued in that capacity until his death. Colonel Swan was amongst the pioneers in the construction of steamers specially built for carrying petroleum in bulk. The construction of ice-breaking steamers also received his attention. In the year 1894 the firm built two ice-breaking and railway ferry steamers for service on the river Volga. These vessels were followed by the railway ferry ice-breaker *Baikal*, and the ice-breaker *Angara*, both of which were built to the order of the Russian Government to cross Lake Baikal in connection with the Siberian railway system. It was these two vessels that worked so successfully in conveying the troops across Lake Baikal on their way to the seat of the war with Japan. Colonel Swan was chairman of the Wallsend Slipway and Engineering Company (Limited), and a director also of the Weardale Steel, Coal, and Coke Company (Limited), and of the Bucknall Steamship Lines (Limited). He was elected a Member of the Society of Arts in 1883.

GENERAL NOTES.

British Manufactures in Japan.—In his report on the trade of Kobe, just issued (Cd. 3727-25), Mr. Consul Bonar expresses the opinion that there is a great future for industrial undertakings by foreign manufacturers, or with the support of foreign capital, in Osaka; but British enterprise in that direction is still wanting. Belgian and French capital, with a very small proportiou of British (privately subscribed) has already been instrumental in bringing about the formation and installation of at least one enterprise, which is about to commence operations, namely, the manufacture of glass. If British manufacturers would carefully study the import returns given in the Consular reports every year, they should have no difficulty in perceiving not what outlets they have for their manufactures in this country, but what the prospects are of profitable manufacture (on the spot), such as the Customs tariff is specially directed against, and which, owing to the want of expert knowledge and capital, the Japanese are as yet unwilling to engage in. In the last few years, Japan has seen a number of agents of British financial houses or syndicates offering to provide money for this or that undertaking, but the British manufacturer, or his expert, has been conspicuously absent. Mr. Consul Bonar considers there is good reason for supposing that those who decide to venture on industrial undertakings which Japan does not yet possess, or only possesses to a small degree, will have reason to be satisfied with their experiments.

Technical Libraries.—It is well-known that American employers give much more attention than has been the practice in this country to affording facilities to their managers and workpeople for obtaining technical knowledge. For example, a large organisation of spinners and manufacturers at Atalanta (Georgia) has adopted the following scheme for keeping their employees up to date in commercial and technical knowledge of the textile trade. A librarian is employed to secure all the latest books dealing with spinning, weaving, and textile engineering; all weekly, fortnightly, monthly, and quarterly periodicals bearing on the subjects are purchased, as well as every kind of year book. These publications are obtained from all parts of the world. The librarian prepares brief descriptions of the books, to which anyone may refer to get a quick idea of the contents. In some instances the whole periodical is filed; in others special articles are cut out, and sometimes foreign articles are translated and pasted in scrap books. Everything is carefully indexed, and the library is open to any *employé*.

Spanish Business Methods.—In the course o his report on the trade and commerce of Spain (Cd. 3727-40), Mr. S. P. Cockerell, Commercial Attaché to H.M.'s Embassy at Madrid, refers to Spanish business methods, and remarks upon the domination of the chivalrous over the commercial instinct in the majority of Spanish traders. They will buy from foreigners known to them an inferior and expensive article in preference to a better and cheaper one from a stranger. This may be a reflection of the lack of confidence which Spaniards have among themselves, which leads them to trust only those whom they really know, but to trust them implicitly once they know them. Again, Spaniards are very conservative, and prefer to continue with an article of fair quality only, which they know, rather than try any experiments with the unknown, although it may be better. They take, says Mr. Cockerell, instinctively the line of least resistance, a characteristic which it is important to appreciate in dealing with them, and which makes it desirable to eliminate wherever possible the difficulties and details which are usually left to the importer to deal with. For this reason, also, the use of British measures may place those who use them at an even greater disadvantage in Spain than in many other countries, in competition with those who employ the metric system. Considerable development has taken place in Spain in recent years—railway facilities are greater, and commercial travellers, mostly German, are to be found everywhere. But there are still many places out of touch with the big centres in which detachments from the general advance leaves unaltered in its general lines what has been said above.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

APRIL 8.—"Technical Education in America." By SIR WILLIAM H. PREECE, K.C.B., F.R.S. CHARLES MOBERLY BELL will preside.

APRIL 29.—"Modern Roumania." By ALFRED STEAD, Consul-General for Roumania. SIR PERCY SANDERSON, K.C.M.G., will preside.

MAY 6.—"The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE.

MAY 13.—

MAY 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. MARTIN DUNCAN.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

APRIL 7.—"The Imperial Problem of Asiatic Immigration." By RICHARD JEBB. The RIGHT HON. ALFRED LYTTELTON, K.C., M.P., will preside.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

APRIL 28.—"Lace as a Modern Industry." By Miss ISEMONGER. ALAN S. COLE, C.B., will preside.

MAY 26.—

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 6...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Mr. H. C. Duncan Scott, "The Destruction of Arch Bridges."

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Professor J. Logan Lobley, "History of the Spread of the North American Fauna."

TUESDAY, APRIL 7 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Colonial Section.) Mr. Richard Jebb, "The Imperial Problem of Asiatic Immigration."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. A. Wallace Budge, "The Egyptian Sudan: its History, Monuments, and Peoples, Past and Present." (Lecture III.)

Alpine Club, 23, Savile-row, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Messrs. F. W. Davis and C. R. S. Kirkpatrick, "The King Edward VII. Bridge, Newcastle-on-Tyne."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. C. Willie, "The Gum-Bichromate Process."

Zoological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Lord Strathcona and Mount Royal, "The All Red Route."

Optical Society, 20, Hanover-square, W., 8 p.m. Prof. Burch, "Colour Vision."

WEDNESDAY, APRIL 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C, 8 p.m. Sir William H. Preece, "Technical Education in America."

Naval Architects (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.) Annual Conference. 11½ a.m. 1. Address by the Chairman, the Earl of Glasgow. 2. General E. E. Goulaeff, "Unsinkable and Uncapsizable Ships of the Goulaeff Form and System of Construction." 3. Captain T. J. Tresidder, "Modern Armour and its Attack." 4. J. E. Thornycroft, "Modern Torpedo Boats and Destroyers."

THURSDAY, APRIL 9...Naval Architects (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.). Annual Conference. 11½ p.m. 1. Hon. C. A. Parsons and Mr. R. J. Walker, "The Combination System of Reciprocating Engines and Steam Turbines." 2. Mr. Thomas Bell, "Speed Trials and Service Performance of the Cunard Steamer *Lusitania*." 3. Mr. J. W. Isherwood, "A New System of Ship Construction." 4. Mr. W. Carlile Wallace, "The Heating of Modern Ocean Liners." 7½ p.m. 1. Mr. D. B. Morison, 1. "The Influence of Air on Vacuum in Surface Condensers." 2. Monsieur Félix Godard, "Note on the Use of Superheated Steam with Marine Engines."

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Lydekker, "The Animals of South America."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Messrs. H. W. Handcock and A. H. Dykes, "Electric Supply Prospects and Charges as Affected by Metallic Filament Lamps and Electric Heating."

FRIDAY, APRIL 10...Naval Architects (at the HOUSE OF THE ROYAD SOCIETY OF ARTS, John-street, Adelphi, W.C.). Annual Conference. 11½ a.m. 1. Mr. R. E. Froude, "Results of Further Model Screw Propeller Experiments." 2. Professor William Hovgaard, "An Analysis of the Resistance of Ships." 3. Herr H. Wellenkamp, "A New Method of Research Work on Fluid Resistance and Ship Propulsion." 4. Mr. W. S. Abell, "Two Notes on Ship Calculations." 7½ p.m. 1. Professor J. O. Arnold, "Factors of Safety in Marine Engineering." 2. Mr. J. C. Dobbie, "The Modern Developments of the Mariner's Compass."

Royal Institution, Albemarle-street, W., 9 p.m. Professor J. J. Thomson, "The Carriers of Positive Electricity."

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Paper on "Old St. Paul's."

Astronomical, Burlington-house, 5 p.m.

Physical, Royal College of Science, South Kensing-S.W., 5 p.m. 1. Professor W. H. Bragg and Mr. Madsen, "An Experimental Investigation of the Nature of the γ Rays." 2. Miss D. D. Butcher, "Experiments on Artificial Fulgurites." 3. Mr. W. Duddell, "Short-Spark Phenomena."

SATURDAY, APRIL 11 . Royal Institution, Albemarle-street, W., 3 p.m. Prof. J. J. Thomson, "Electric Discharges through Gases." (Lecture VI.)

Journal of the Royal Society of Arts

No. 2,890. VOL. LVI.

FRIDAY, APRIL 10, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

HOWARD LECTURES.

Dr. H. S. HELE-SHAW, F.R.S., delivered the third and last lecture of his course on "The Navigation of the Air" on Thursday evening, 2nd inst.

On the motion of the Chairman (SIR BOVERTON REDWOOD) a vote of thanks to the lecturer was carried unanimously.

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 8th, 1908; CHARLES MOBERLY BELL in the chair.

The following candidates were proposed for election as members of the Society:—

Brown, Lawrence Combe, Department of Agriculture, Kwala Lumpur, Selangor, Federated Malay States.
Carvalho, David N., 265, Broadway, New York City, U.S.A.
Collier, George H., "Woodcote," 17, Southend-road, Beckenham.
Corfield, Wilmot, 25, Mangoe-lane, Calcutta, India.
Furnival, Samuel B., Hilltop House, Stoke-on-Trent.
Golds, Alfred, M.R.San.I., Royal Engineer Office, Bordon Camp, Hants.
Pillai, A. R., Trivandrum, Travancore, South India.
Tagore, Abanindro Nath, 6, Dwarka Nath Tagores-lane, Calcutta, India.

The following candidates were balloted for and duly elected members of the Society:—

Agbebi, Rev. Mojola, D.D., Lagos, West Africa.
Allen, Henry Edward, Assoc.I.M.M., Ashanti Goldfields Corporation, Limited, Obuasi, Gold Coast Colony, West Africa.
Belknap, Henry W., 31, Warren-street, Salem, Massachusetts, U.S.A.
Bird, Mrs. Charles Sumner, Endean, East Walpole, Massachusetts, U.S.A.
Carder, Frederick, Steuben Glass Works, Corning, New York, U.S.A.
Esch, Vincent J., Architect's Office, Bengal-Nagpur Railway, 11, Garden Reach, Calcutta, India.
Gupta, K. G., 57, Tregunter-road, South Kensington, S.W.
Kilmorey, Earl of, K.P., 5, Aldford-street, Mayfair, W.
Lal, Rai Brij Behari, B.A., LL.B., Moradabad, United Provinces, India.
Power, William Mailes, Victoria Gallery, 123, Victoria-street, S.W.
Richards, Charles Henry, Garforth, Melrose-road, West-hill, S.W., and The Crotons, Coromandel P.O., South India.
Williams, John T., Brockhampton, Bromley-common, Kent.

The paper read was—

TECHNICAL EDUCATION IN AMERICA.

By SIR WILLIAM H. PREECE, K.C.B., F.R.S.

On April 11th, 1907, I took part in the opening of the Technical Schools of the Carnegie Institute of Pittsburgh, which were founded on Nov. 15th, 1900. The Institute started as a Library in 1892, with a gift of 1,000,000 dols. from Mr. Carnegie, supplemented by another million dollars in 1895 and by subsequent gifts, which have now amounted to 20,000,000 dols. (£4,000,000). The enjoyment of literature, art, music and science has thus been placed within the free reach of every citizen of Pittsburgh.

The Institute is managed by a Board of Trustees of 36 members, all prominent, able, and distinguished inhabitants of Pittsburgh, which has a municipal population of 750,000 people. Pittsburgh is situated on the coal, natural gas, and oil fields, it is the home of the industries of iron and steel, and of great

and prosperous glass and leather manufactures. It has great water and railway transport, and is surrounded by a district of 2,000,000 souls. It is the industrial centre—the Birmingham and Sheffield—of the United States.

The scheme of the Institute has evolved gradually into departments of (1) Library, (2) Fine Arts, (3) a Museum of Natural History, (4) a School of Music, (5) a School of Technology. It is with the latter department that I propose to deal in this paper. Thirty-two acres of land were allocated by the city authorities of Pittsburgh to the Institute upon which the new Technical Schools should be built.

There are four distinct organic divisions of this new department of Technology:—

1. A school of Applied Science.
2. A school for Apprentices and Journeymen.
3. A school of Applied Design.
4. A school for Women.

I purpose illustrating the buildings by slides. The inception of these schools resulted from a visit Mr. Carnegie made to the Keighley (Yorks) Institute in September, 1900. Mrs. Carnegie distributed the prizes there to the successful winners among 1,206 competitors. In taking part in this function, her husband referred to an article written by his grandfather in "Cobbett's Weekly Political Register" (1802-1835), entitled, "Handification *versus* Headification," in which the grandfather thanked God that in his youth he had learnt how to make and mend shoes.* It is gratifying to learn that Great Britain has had some influence in stimulating the advance of technology in America.

It is remarkable that the Press of this country glories in bewailing the imaginary backwardness of its own country, and that this national depreciation is even heard within the walls of Westminster Palace. We have no reason to lament the progress of technology at home. It has not been so liberal or so wide-reaching as in America, but Government and municipal authorities have been by no means niggardly all over the country. Indeed our Government allocates about £1,000,000 per annum of the drink taxes to this purpose. Our complaint is that the wealth of our fortunate citizens does not flow freely in the direction of educational endowments. Notwithstanding persistent, and sometimes undignified begging, our ancient universities themselves are sadly checked in modern progress by the want of funds and of patriotism in their *alumni*.

It is extremely difficult, if not impossible, to obtain accurate statistics to determine the relative amounts of the immense sums of money bequeathed and contributed to religion, charity, hospitals, and education in the United Kingdom. In London alone it was over £10,000,000 in 1906, but of this only £123,778 was allocated to education. The total amount over the whole country must have exceeded £50,000,000, and of this probably only one per cent. was devoted to education! Distribution of wealth is much a matter of fashion, and for some unaccountable reason education is tabooed. Very recently Cambridge and Manchester have benefited largely, but this was accidental in the one case, and only a fraction of the immense sums left by Mrs. Rylands in the second case. In America it is not so much by legacy that wealth is bestowed, as by the living millionaire, who, perhaps, derives the greatest joy and satisfaction from his munificence, in distributing his surplus wealth for the good of others.

The type of education—the mental preparation for practical life—in their technical schools, has been designed to meet the local, economic, and industrial needs of Pittsburgh. They form at present, in their noviciate stage, more a trade school than a college of technology, but they have a great future before them, and they will probably grow into a well co-ordinated academic system embracing all branches of preparation. I have always defined technical education to be that form of teaching which trains the brain to assist the hands. This definition may now be extended to embrace the senses, aud especially to that of *sight*, and even that of *touch*. Like science itself it also develops the perception of truth. It means the addition of thought, reason, and judgment to mere manual craft. It excites the "reason why" for every operation. Adopting Mr. Carnegie's grandfather's terms, it is handification *plus* headification. Every industry is based on natural facts, and the most successful workman is he who is able to apply the facts of nature, and the dictates of common sense, which is science, to produce the greatest economical effect from the least expenditure of energy by sensuous, manual, or mechanical operations. Hence technical education means

* Mr. Carnegie also about the same time addressed the Halifax Institute, where there were about the same number of students. I am not sure at which place he referred to his grandfather.

an economical advance upon general education, and is supplementary to ordinary board or public school tuition.

There are numerous discordant variations of industry in all great manufacturing centres which employ different classes of students. This demands specialisation for their various callings. Each centre has more or less to provide for its own wants. It has to regard the people of both sexes and the industries and occupations which make them breadwinners.

We must brush aside all questions of general education and of sex, and assume that we are dealing with those who have at least passed through a fair education of a primary character and can pass a moderate entrance examination. They must be prepared to grasp the meaning of the facts and principles which lie at the root of the business in life that is going to enable them to earn a living and to make them experts.

The people to be provided for are workmen and workwomen, apprentices and journeymen, assistants and helpers, foremen and supervisors, designers and draughtsmen, engineers and managers, and above all masters, for more depends on the qualifications of the master than on those of the staff.

Thus Technical Education like General Education divides itself into three classes :—

1.—Primary.
2.—Secondary.
3.—Advanced.

And the Schools into—

1.—Trade Schools.
2.—Colleges of Technology.
3.—Universities.

Primary technical education is that required by workmen and foremen, and is provided for by Trade Schools. Secondary, that required by draughtsmen, designers, and supervisors, is provided for in Colleges of Technology. Advanced is that required by Post Graduates, Teachers, Engineers, Architects, and Manufacturers.

The industries affected in Pittsburgh are :—Building, mechanics, manufactures, designing, illustration, decoration, electricity, iron and steel making, metallurgy, glass making, ceramics, gas, power generation and distribution, petroleum products.

It was estimated that provision should be made in the new schools for 4,000 students, and at the time we visited Pittsburgh 1,374 had entered themselves. We were present at the inauguration of the buildings required for the first year students. The buildings for the second year were in hand, and are now occupied. The third and fourth year buildings are also in hand and will be ready to receive their occupants when they have completed their prior terms. There is little doubt that the estimate will be reached.

The classes and the number of students that have so far (1907) been formed are :—

I.—*School of Applied Science.*

DAY—Junior		77
	*Plebe	72
NIGHT—First year		122
	Second year	92
	Preparatory	244
	Total	610

II.—*School of Applied Design.*

DAY—Junior		5
	Plebe	18
NIGHT—		57
	Total	80

This school provides day courses in architecture and night courses in architectural design adapted to draftsmen.

These two engineering schools deal with electrical, mechanical, civil, chemical, mining and metallurgical practice.

The night school provides courses for those who cannot attend the day school. They are for men of mature years who are engaged in practical employment. There is a preparatory course for the night students in mathematics, physics, chemistry and English.

III.—*School for Apprentices and Journeymen.*—This school has three distinct divisions offering separate courses of instruction :—(1) Day courses in mechanical drawing in the machinery and building trades; (2) night courses for apprentices in the same trades; and (3) night courses for journeymen in the same trades.

DAY — Industrial Course........ 36

		Journeymen.	Apprentices.
NIGHT—Building Trades	(Middle)	22	—
	(Lower)	22	—
Plumbing	(Middle)	11	23
	(Lower)	11	23
Sheet Metal and Cornice Work	(Middle)	7	11
	(Lower)	8	11

*The term "Plebe" is a local term applied to all newcomers on entering for their first year into the province of "Tech"—the familiar name of the Carnegie Institute. It is derived from the Latin word *plebs* or *plebes*—the lower class or common people.

		Journeymen.	Apprentices.
NIGHT.—Machinery	(Middle)	22	—
	(Lower)	42	—
Bricklaying	(Middle)	13	—
	(Lower)	11	—
Electric Wiring	(Middle)	14	—
	(Lower)	14	—
House Painting	(Lower)	15	—
Sign Painting	(Middle)	10	—
	(Lower)	12	—
Blacksmithing and Forging	(Middle)	13	—
	(Lower)	8	—
Machine Work	(Middle)	25	—
	(Lower)	26	—
Moulding and Foundry Work	(Middle)	10	—
	(Lower)	11	—
Pattern-making	(Middle)	13	—
	(Lower)	22	—
Chemical Practice for Foundry Foremen	(One class)	15	—
Total		485	

IV.—*School for Women.*

DAY—Ordinary	34
Drawing	10
Millinery	24
NIGHT—Book-keeping	26
Cooking	14
Millinery	17
Sewing	36
Stenography	30
Drawing	3
Total	199
GRAND TOTAL	1,374

The fees in each school are very moderate. They are, per annum, for—Residents in Pittsburgh, day, 20 dollars; night, 5 dollars. Others, day, 30 dollars; night, 7 dollars.

It will be seen that the classes were in the tentative condition which is only to be expected in a novel venture. They were formed as the buildings were completed and prepared for occupancy. The schools open in the second week of September and close in the third week of June. The regular night classes are on Monday, Wednesday, and Friday. The preparatory classes on Tuesday and Thursday. Saturday is a whole holiday. Mr. Hamerschlag, the Director, has since paid a visit to Europe and has doubtless imbibed fresh ideas which will be impressed on the future curriculum.

The great library with its 50,000 volumes on technical subjects and all the galleries are open at all times to the students, and every facility is given them for pursuing their studies in the arts and sciences.

The class rooms are purposely small so as to bring teacher and student into such close contact as to insure easy and effective instruction.

Technical education is more the result of self acquisition than of professional impartation, and the true secret of success is to place within easy access of the student every possible means of enabling him to acquire facts for himself. It is for this reason so important that he should be instructed with the very tools and processes he uses in his own work, and that technical shools should be fitted up with actual machines in use and not with mere models. In my own personal experience in telegraphy, I invariably used the very apparatus that the student would have to use, and put him through the various processes of construction and maintenance he would have to supervise or exercise. Nothing could have been more successful. The practice of Telegraphy in the United Kingdom, in India, and in our Colonies, is a certificate of the success of the Technical training that I was allowed to introduce. This lesson has been learnt by similar experience in America, and it is being thoroughly carried out in Pittsburgh, and indeed all over America.

It is for this reason also that the instructors should be practical men, and that in all engineering colleges they should be kept in touch with experience. The academical professor, who has lived a secluded life in some university town, is, in the language of our American friends, the worst teacher on earth. His knowledge of life is limited, but his value of his own qualifications is excessive. The knowledge he has imparted has often to be unlearned.

And, on the other hand, the university trained teacher who has had practical training in the world, makes an ideal professor. There is a very competent and well selected staff of 111 officers in the Carnegie Technical Schools. They are divided thus—

Executive Staff	9
School of Applied Science	49
School of Applied Design	29
School for Apprentices and Journeymen	8
School for Women	16
Total	111

The average number of pupils per teacher is 13.

I visited the Westinghouse Electrical Works in Pittsburgh—an enormous establishment in full work—a picture of organisation and method. All their heads of departments, supervisors, and inspectors, are college graduates and trained scientific assistants. They have an electric club, and publish their own transactions. The works bear the impress of culture, science, and technical training. Commercial methods are as prominent as scientific acumen.

Culture is never neglected in America. An eminent scholar said to me, "In the university there should be 90 per cent. humanities, and 10 per cent. technology. In the technological college, 90 per cent. technics, and 10 per cent. humanities."

The Americans have the practice, in all their commercial and scholastic undertakings, of placing the chief executive power in the hands of one competent authority, who is entrusted with great personal power and responsibility, and who is selected with great care. I have been brought in contact with many of these Presidents and Directors, and I have been greatly impressed with the marked success that has characterised their selection. I have failed to fathom the process. Heads of universities, telegraphs, telephones, railways, electric light and power companies, manufactories and distributing agencies have all in my experience been the right men in the right places, and they have been successful autocrats. This is one great feature of American success, not only in financial but in educational movements. It is eminently so in the technical schools, and markedly so in the case of the Director of the Carnegie Institute Technical Schools, who recently passed through London, and who impressed every one with whom he was brought in contact, not only with the breadth of his views, but with his mastery of details.

It is satisfactory to find that games and social functions are not neglected. We were each of us presented with a copy of "The Thistle," an annual record of student life, and of baseball, football, athletics, hockey, &c. events. It is admirably written, sparkling with American wit, and full of interesting information. The students' cheer in America is peculiar. The line from the Schenley Hotel, whence we processed to the Carnegie Institute, was lined with students who shouted in stentorian unison as we passed—

A.N.D.R.E.W. C.A.R.N.E.G.I.E.

Rah! Rah! Rah!

TECH.

Clubs and Societies are being formed in the schools to encourage music, literary and engineering discussions, &c. Every effort is made to aid the interchange of ideas and the development of wide views of life. Home life is not neglected, and houses are equipped for the use of those whose homes are at a distance from Pittsburgh. Room and board is extremely moderate. Everything indicates the birth of the true college spirit and the foundation of a strong university *esprit de corps*.

The system of apprenticeship in the United States as in the United Kingdom is now virtually a function of the past, and one of the chief endeavours of the primary technical schools is to replace apprenticeship by technical training. Another important object is to make the various industries less dependent on imported skilled labour. It is remarkable that in 1902 a careful inquiry showed that in New York the percentage of skilled foreign labour was 70 per cent., in Chicago 60 per cent., and in Brooklyn 75 per cent. It is hoped that such institutions as the Pittsburgh Technical Schools will gradually reduce this remarkable proportion. The type of student in the primary School of Apprentices and Journeymen is most promising. This is evident in the photographs I showed, but it was very impressive in the inspection of the schools. The type of student in Pittsburgh is quite equal to that of our provincial universities, and nothing surprised me more than the character of the apprentices and journeymen who study and practice with all that wonderful energy that is such a marked feature in American life. This imbibed energy is not a question of race, but one of climate, for it affects all those who go there, whatever their nationality. It is as evident in the teacher as in the pupil. It is the exciting influence that generates a craving for education. The American boy in every branch of life will know "all about it," and there is no need of stimulation, for he is born with the spirit of ambition, and he is actuated by the national love of progress and the determination to win his own bread and make his own fortune. He is determined to acquire handiness and skill in pen, pencil, brush, and tools, and he is as keen in the pursuit of games in the playing fields as in the pursuit of knowledge in the class-room. He has a natural aptitude for acquiring scientific methods and

habits, and he speedily masters the rudiments of his trade, business, or profession.

It is impossible to avoid observing the determination to advance rapidly in a well-matured campaign of educational progress in the United States and in Canada. There is no fixed system directed from some central headquarters. Every college has its own system. Hence there is a great variety of organisation and practice and a marked impression of the personal element. There are a number of isolated institutions. They number between 500 and 600. They have no supreme Government Education Department in Washington, but every State deals with its own domain. Education is not a political question as with us. By intuition rather than by rule a course of action has been prescribed, and by the financial aid of those millionaires who have amassed wealth they are able to co-ordinate together all lines of education — primary, secondary, advanced, technical, and academic; so that they work together towards a final goal of culture and skill. Each class is directed in the proper channel to reach that special state of mental cultivation and manual skill which is best suited for its own wants and ends.

The old universities of America do not differ very widely from their ancestral type in the old country. The oldest of this class are Harvard, Yale, Princeton, Cornell, Johns Hopkins' (Baltimore), and Columbia (New York), &c. I had, on previous occasions, visited Harvard and Johns Hopkins', and on my recent visit was prevented going to Cornell. Cornell was founded by Ezra Cornell in 1807. Its centenary was celebrated last year. Indeed they were all founded by private endowment, and are maintained by the same means.

The best known State Universities are those of Michigan, Minnesota, and Illinois. The leading technical colleges are the Massachusetts Institute of Technology (Boston), the Stevens Institute (Hoboken), the Armour and Lewis Institutes, Chicago, the Pratt Institute, Brooklyn, and the Worcester Institute of Technology. There is also a very fine Trade School in New York.

In all these colleges art and culture are decreasing in popularity, while the practical and utilitarian faculties are increasing with giant strides. At the same time the "humanities" are not neglected, for the doctrine is preached that, without art, letters, science, and philosophy a nation, no matter how great its other achievements, is essentially barbarian. I take Cornell. In 1905-6 the alumni were distributed thus:—

Graduates*	232
Arts and Science	705
Law	222
Medicine	482
Agriculture	230
Architecture	81
Engineering	1,521
Total	3,461

of whom 371 were women. This shows that the American University is becoming a National College of Technology.

The students are not so much the children of the rich as, like the Scotch, the offspring of those of narrow means. The scholarships and Bursarships of the United Kingdom are not apparently so much in evidence, but there are 600 scholarships in Cornell. Nor is the professor, curiously enough, so well paid, and in consequence he has not been, in the past, so permanent and continuous in office, for promotion has necessitated too much migration. The absence of a pension system has given insecurity, but this has been remedied by the munificence of Mr. Carnegie, who has given 15,000,000 dollars as a "Foundation for the Advancement of Teaching." Mr. Carnegie's gift includes Canada. Professors now have the right to pensions as we have in our civil and military services at home. The age of retirement is 65. Anxiety is relieved and security is added, and provision is made for old age, as well as for widows, who are allowed half-pay.

Mr. Rockefeller has also given 10,000,000 dollars for the improvement of higher education in the colleges, whether undenominational or privately endowed. This has enabled the trustees to raise the incomes of the chairs, and so to meet the increased cost of living, and to improve greatly the tenure of office. Everything is progressing, but in spite of the munificence of the millionaire the cry is—as with us—that of the horseleech's daughters—"Give, give."

In Cornell there is a professor of physical culture, and one of elocution and oratory. Indeed, this is found in most colleges, but the English practice of leaving the control of the games to an elected committee or club is also very prevalent.

The trustees are very free with their sabbatic leaves, by which professors are relieved of overwork, and are given facilities, not only to rest from labour, but to seek fresh health and gain new ideas by foreign travel.

* Graduates are fifth year students who have acquired their degrees.

The traditions of Great Britain are found in the names and nicknames of annual progress —freshmen, *plebes*, *sophomores*, undergraduates, graduates, &c., but the influences of the playing fields, the river, and the road are as powerful as at home in moulding character and in promoting health, good fellowship, honour, discipline, self-reliance, and powers of command. Military instruction is given under the ægis of their War Department.

It is difficult if not impossible to make any just comparison between the methods of technical education in America and those at home. The conditions are totally different. Climate, race, commerce, industry, fashion, wants, and aims are different. We are a conservative, archaic nation, well provided with inertia, not wanting in wealth, accustomed to grandmotherly attentions, subject to the traditions of the past, and swayed by the precedents of our grandfathers. America is a congeries of numerous self-governing States, intensely ambitious, enjoying a champagne-like climate, formed of a mixture of all the Celtic, Teutonic, and Latin races of Europe, inspired by a rapid and excessive flood of the wealth of the soil and the demands of a phenomenal inroad of aliens; abounding with advancing commerce and growing industry, and suffering from a great inroad of wealth and an immature system of finance. The American boy, the training of whose mind we are considering, possesses the energy and smartness of a new race. The European boy is mentally two years behind him. His precocity is assisted by his keenness and his vivacity. He works with an object and a determination to succeed. He throws the same determination into his studies that he applies to his games. He is irresponsible and sometimes a terror. The absolute unfitness of these characteristics to the British boy must be self-evident, but they will account for the differences in the curricula, and the papers set for examination provided for these boys when they become students in colleges and universities.

Teachers, like poets, are born, not made. The teachers differ but little from those in Europe, but they are excited to greater energy by their natural enthusiasm, by climatic influences, and by the reflected encouragement of their receptive pupils. Indeed, many are imported from France, Germany, and the United Kingdom, and I should like to see the reverse operation, for there is much to be gained by a process of blending in professorial ranks. We want new blood at home. We have made a bold start here by appointing Dr. Henry Bovey (M.A., Cambridge), of the McGill University (Montreal), the Rector of our new Imperial College of Technology, in South Kensington, and there is every reason to anticipate complete justification for his selection.

It is in the behaviour of the employers and captains of industry that even a greater characteristic is evident. They, in America, not only appreciate, but assist in noble ways, the acquisition of scientific attainments in their *employés*. The premium system, such a serious check at home, is abolished, and they select only those who can submit diplomas. They fully recognise the advantage of technical attainments, they encourage research, they equip their own laboratories, and they support college and university by financial help, and by the gift of machinery. The lavish supply of apparatus in every technical school, so marked a feature in American institutions is thus accounted for, and make our equipments simply insignificant. The American master recognises the fact that pupils are best trained by means of the very apparatus that they will have to tend. Even the works in many cases become advanced classes of the college. The marked distinction in American practice is the adoption of the four years' course—which we certainly ought to adopt at home.

The course of education in America, from the nursery to the workshop, may roughly be graduated thus:—

		Years old.
School—1	Primary	6 to 10
„ 2	Secondary	11 to 13
„ 3	High	14 to 16
College—4	Literature and Science.	17 to 20
Technical—5	Practical and Scientific Training	17 to 20
University—6	Culture, Research, and Investigation	16 to 21

Though not specified, or even regulated, it is quite evident that in America all are working on fixed methodical lines, and that gradually a national co-ordinated system will be evolved which will make the United States the best secularly educated country in the world, and their education policy thoroughly organised.

In nearly all discussions on this question, it is the well-prepared boy that attracts most attention. But the extremes deserve equal consideration, the *workmen* at one end and the *master* at the other. The latter is rapidly

curing himself, but the former needs much encouragement for he has to bemoan in the United Kingdom a very crude and valueless primary education. Evening classes and trade schools are meeting the case of the thoughtful and ambitious mechanic, but the difficulty is in the sympathetic and enthusiastic teacher—a scarce article. The results and economies depend on the workman, and his education is of as much consequence as that of his superiors. It is the ambitious, self-educated British workman who has often become the successful master in the past, and we must not shut him out.

The American has always been impressed with the idea that education is essential to the development of a nation. Land grants were instituted by Congress in 1786 for the maintenance of schools and of a literary institution established by the State. The Great Land Grant Act (Morrell) in 1862 apportioned 13,000,000 acres for this purpose, so that each State should found "at least one college where the leading object shall be without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts . . . . in order to promote the liberal education of the industrial classes." The Federal Government in 1890 allotted £5,000 a year to each State for this purpose.

The total grants of land up to 1900 by the Federal Government, were for

Schools	67,893,919 acres
Colleges and universities..	10,765,520 ,,
	78,659,439 acres.

and in addition 50,000,000 dols. in money.

Fortunately for Americans education has been kept outside politics, and it is not as with us the shuttlecock of party. It is recognised as their greatest national asset, and every citizen regards it as his duty to contribute to its promotion.

Each State makes large appropriations for schools and universities, and most of the universities obtain about 500,000 dols. per annum each. There are 17,000 paid professors, lecturers, and teachers in the United States.

Canada is as liberal, and follows its neighbour, and not its mother country in this policy and fashion. The munificence of the millionaire has not been confined to the United States. Canada has her Strathcona, Mount Stephen, Redpath, Molson, and Macdonald. Sir W. C. Macdonald has spent over £2,000,000 upon the McGill University alone in the development of scientific and agricultural departments.

A smart boy in America can get his education practically given free up to 22 years of age. There is everywhere co-education. There is no residential system at the universities. Accredited pupils can pass from the high schools to the university without an entrance examination. There is a close and almost organic connection between academic and industrial life. Culture is not neglected as with us. Teachers are actively engaged in the practice of their professions. We do this in our medical schools only. Why should not the same be done in our technical schools? We have much to learn from American practice.

A careful consideration of American practice developes some serious defects in our general educational system.

1. Children are removed too early from school. The limit here is 11 years, while in France and America it is 13, and in Switzerland 14.

2. Science as a brain trainer is not encouraged enough, and no effort is made to introduce it in our primary schools.

3. There are too many academic traditions at home. Our ancient seats of learning want to be thoroughly shaken up, and a new race of teachers introduced. Exclusive cliqueism has had its day.

4. Our technical schools are not sufficiently supported by our employers, and trained graduates are not welcomed in our works.

5. We want the fourth year for technical training and for specialisation. At the end of the third year the student should know something of everything, but in his fourth year he should learn everything of something that is essential to his life work.

6. The premium system is very restrictive.

There are many exceptions and the frequent intercourse with America is tending to the importation of American ideas. Head, Wrightson, and Co.'s bridge works in Darlington, and Allen's engine works in Bedford are very marked departures from the traditional British workshop. The latter firm have attached to their shops a collegiate course of training in technology.

No action of any association in promoting scientific training in this country has been more far-reaching than that of the Institution of Civil Engineers who organised a much considered scheme of qualifying examinations for

admission into the institution and for promotion in its grades. I am glad to say that I took an active part in originating this movement, and it was the warm support of Sir John Wolfe Barry and the spirited lead of Sir William White that has brought it to a successful conclusion.

Mere academic degrees are not alone sufficient to qualify an engineer to practice. He must have the credentials of actual experience. This is conveyed in the indications of corporate membership of the recognised engineering institutions of this country. The diploma of an engineer can be acquired only by practice and experience, and the admission to the Institution of Civil Engineers is now a diploma that no college or university can bestow.

Thus the effects of technical education are to protect the public, to economise labour, to prevent waste of material, and to apply the great principles of Nature, so as to give the greatest number the greatest happiness, comfort and wealth.

DISCUSSION.

The CHAIRMAN (Mr. Charles Moberly Bell) in opening the discussion, said the sole reason he occupied the chair was the fact that he had the pleasure of accompanying Sir William on his journey to America last year. Whatever might be the cause, it had been forced upon him that technical education in America was enormously in advance of this country. In his own profession he was obliged to say, with very deep regret, that while, so far as he knew, English journalism had nothing to learn from American journalism, English machine makers, press makers, type setters, and so forth had much to learn from Americans. A large part of the machinery for use in the printing trade was coming from America, and was coming, he was afraid, in even greater quantities in the future. One of the reasons for it was the climate, which might be said to be champagne untempered by headache the next morning, and was the most invigorating climate he knew. Another reason was the people of America. In America there was very nearly the pick of every race in Europe. Given ten people in a family, the three that went abroad were probably more enterprising, more intelligent and more likely to push their way in the world than the seven who remained at home, and America received the pick of every nation in the world. The third cause operating against this country, in its competition with America, was the very bad education of the children. The young children in America were left absolutely alone, and allowed to teach their parents. The result might be disagreeable, but an independence was created in the child, which told in the long run, and made him a better man—although it was rather trying to the parents. The next great factor was the absolute democratic equality found everywhere in America. There was no seniority. A man of twenty had no more respect for a man of sixty, than the latter had for the former; they were all equal, and that fact had many far-reaching effects. He remembered that on the journey to Pittsburgh there were a great many distinguished men in the saloon discussing astronomical subjects. The ticket collector was also interested; he therefore went very quickly round the train, collected all the other tickets, and then came into the saloon, put his hands in his pockets, sat down by Sir William Preece, and listened. There was no harm in it, because he did not say a word, or interfere in any way, and nobody thought it strange; but it would be impossible for a ticket collector to do such a thing in England, because he would probably be ordered out of the carriage. Such opportunities occurred to men in America, however, because there was absolute social equality. An enormous advantage was also gained by the money given by millionaires, of whom there were more in America than this country. They had to think of what they would do with their money, and as they could not buy peerages in America, they endowed schools with it.

Dr. MULLINEUX WALMSLEY, in dealing with Sir William's statement that the Carnegie school was to some extent a daughter of the Keighley Technical Institute, ventured to think that the technical schools of America owed a very deep debt of gratitude to those of England. Twenty-five years ago there was opened in London the Finsbury Technical College, which, at the time it was inaugurated, was, in his opinion, the only technical school in the world, including America. He knew the Massachusetts Institute of Technology went back to an earlier date than that, but those who dipped into the history of the subject, would find it was not a technical school in the modern sense of the word. Time and again this country had shown its competitors what to do; they had copied it and gone not one better, but twenty, thirty, or a million times better. The fact that the technical schools in America drew such great support from millionaires was a symptom of a much deeper cause, namely, that everybody in America believed in education; and the money which was acquired by a life time of exertion on the part of some of the millionaires, and was applied to educational purposes, was simply an expression of that general interest which the whole of the country took in the subject. There was not that general interest in this country, and therefore only one per cent. of its large benefactions went to education. The cause of the present state of affairs was the indifference of the average British parent to the needs and possibilities of education. Sir William had stated that a four years' course was essential for a

proper technical college education, and he thoroughly agreed with the statement; but Sir William did not seem to know that that education was available in this country. The parents, however, would not send their sons for a four years' course when they could get a three or two years' course elsewhere, entirely because of the indifference to education which existed. For years American manufacturers had been living upon the old country as far as skilled labour was concerned, 70 per cent. of the skilled labour being imported. Such a thing could not go on for ever, and the time was bound to come when America must face the problem of training its own apprentices, and making its skilled labour native and not foreign. Hence the crowding of students into the technical schools, because the demand was great and inevitable. Sir William, in alluding to the premium system, had put his finger upon a very serious blot in the work of this country. When he was in America five years ago examining into the question, he was disbelieved when he described to the American people the premium system which existed in England; they could not believe that such a system could exist anywhere in the educated world. Unfortunately, the first question asked when a man wished to enter an engineering works was not what his training was, but how much he could pay to go in, which put a stop to all promotion by merit. The premium pupil came in and work had to be found for him, while the diligent pupil or apprentice at his side was pushed into the background. He believed that for the individual firms the premium was a loss and not a gain.

The Hon. RICHARD PARSONS thought Sir William's comparison of the United States with the Old Country was exceedingly interesting, but it was a most difficult one because of the different circumstances connected with trade, education, and everything else in America. America was a new country, and its requirements were very different from those of England. Its trade was highly protected, whereas here the English markets were open to materials being "dumped" on them from everywhere. It was neessary to work much more cheaply in this country than in America, with the result that there was not the same surplus of money, nor the same number of millionaires. The large sums of money which were left to technical institutions in America were conspicuous by their absence here, and great laboratories could not be erected, owing to their cost, without the very greatest difficulties. He personally, by means of persistent begging, equipped a laboratory, but it took him an enormous amount of time and trouble to obtain the necessary money; whereas in America large sums were left wholesale for such purposes. The root of the evil was that the manufacturers of this country did not appreciate education. He made an attempt twenty years ago in Leeds to induce the manufacturers of that city to take the students of the Yorkshire College into their works without a premium, and he absolutely failed except in two cases, the manufacturers telling him that they did not appreciate the education that was given. Since that time technical education was much better appreciated, and he believed by degrees it would be still more so; but in a new country like America progress was very much more rapid. The Old Country took a very long time to wake up, but it would have to do so, otherwise it would be absolutely left behind.

Mr. FRANCIS OWEN thought the cause of the backwardness of education in this country was that there was no desire on the part of the lower classes for it. One of the reasons for that condition of things was that the teachers had been forced into a groove, and were obliged to follow the code without any freedom being allowed. The inevitable consequence was that the teacher drummed the facts relating to the syllabus into the heads of the children with the result that all spontaneous impulse in their minds was stifled.

Mr. LEON GASTER said that having visited the States last year in connection with the opening of the Engineering Societies Building in New York, he was very much struck by the spirit of co-operation which prevailed amongst the different professions, undoubtedly due to the influence of proper education. When Mr. Carnegie was first approached to give one and a half million dollars for the erection of a combined engineering building, it was thought that the questions of precedence would make it impossible for the societies to combine; but a spirit of good feeling prevailed, and the scheme was a gigantic success. He thought the moment was opportune for the erection of a similar Engineering Societies Building in this country. He had noticed that in the technical education of America the students were also educated to use their sense of sight to the most advantage. Illuminating engineering was receiving great attention just now in many colleges and universities, and great progress had been made, in regard to the proper use of artificial methods of lighting. Unfortunately students in this country even after four or five years study, were not sure of getting adequate remuneration after they left the schools and workshops; but the exact opposite was the case in America. The students went from the college to the workshops, and at once commenced to receive wages, and if they showed ability were pushed ahead.

Mr. A. W. OKE thought that in this country one great necessity was more enthusiasm in the teachers. There was very little enthusiasm in the pupils, but there would be more where there was an enthusiastic teacher. If American teachers were more enthusiastic than English, they ought certainly to be introduced into the country. A good deal more should also be thought of the inside of the colleges than of the outside. Very often a fairly large sum of money was spent on the buildings and then the equipment and the pay of the teachers was scamped.

Sir William Preece, in reply, said he was very much indebted to Dr. Walmsley, who, five years ago, visited America and, on his return, read a paper containing his experiences before the Institution of Electrical Engineers, and he (Sir William) had picked up some wrinkles from that paper which he had embodied in his own without, he thought, proper acknowledgment. The Chairman's story about the ticket collector recalled to him a conversation he had with a workman on one of his three previous visits to the States on the question of the difference between the behaviour of the men to the masters in the States compared with that at home. He remembered saying to the man, "Would you treat our Sovereign if she came over here as you treat your President?" and he replied, "Certainly; why shouldn't I? We are all sovereigns here." That idea percolated through all Americans, and one did not resent it in the States, although one would in this country. The chief point Dr. Walmsley made was the indifference of parents to education. He had pointed out strongly in the paper that the American nation, from its inception, saw that its chief asset was education, and ever since then they had been educating. The principal object in life of every man in America was to encourage education, and he did so to his heart's content, as evidenced by the enormous amount of wealth given to it. But there was a great amount of wealth distributed in this country every year, even more, he thought, if a comparison were made, than that distributed in America. The wealth, however, was given to the church, to charity, and to hospitals. He did not object to the hospitals receiving the money, but he did object to only 1 per cent. of it going to education, and 99 per cent. to other purposes. In his opinion, if anything in this world was a part and parcel of government and municipalisation it was the hospital, because it affected everybody. When fashion changed, the money which was now given to the hospitals would have to be found by the municipalities. He disagreed with Mr. Owen's remarks on the subject of the education of children so far as they applied to the United Kingdom. The education in Wales was not so bad as it was in England; and there was another part of the Empire where it was equal to education in any other part of the world—namely, Scotland. The fact was forgotten that John Knox, in the days of Queen Elizabeth, laid down the law that every Scottish child should be taught to read, write, and cypher. He remembered, in the course of a conversation with a gillie, saying to him, with the idea of "stumping" him, "What mathematics did you learn at your school?" The gillie replied, that the Dominie one day told a friend and himself, to find out the height of a tree, in front of the school, without climbing it or throwing up a piece of string. It took him a week to do it; but one day, having a stick in his hand, he noticed its shadow, and wondered if there was any relation between the length of the shadow of his stick and the length of the shadow of the tree. So they worked it out, and got the height of the tree right to within a foot. He thought it would be of interest if he mentioned that among the best teachers which he came across in America were Englishmen, who by some sort of electrical contact seemed to get the champagne effect which had been mentioned. The electrical industry had done a wonderful thing in this country, it having been turned into an occupation for young gentlemen. There were in the central stations and power houses all over the country young gentlemen in positions of trust and responsibility, who did not care how dirty their clothes were, but who took as much pride and pleasure in keeping their machines well oiled and greased, as the highest trained workman in the world. A great benefit had been conferred upon this country by an industry which had an attractive effect upon those who otherwise might lead an idle life.

On the motion of the Chairman, a hearty vote of thanks was accorded to Sir William Preece for his interesting paper, and the meeting terminated.

TRADE WITH EASTERN PERSIA.

There is a small colony of Indian traders in Seistan and Kain, who, it is said, do thriving business on the "large profits and slow returns principle," and whose experience seems to prove that there is good opening for increased British trade in these parts of Eastern Persia. At present the trade of England and India with Seistan and Kain is practically confined to about a dozen commodities, the chief of which are cotton piece goods and yarns, valued at Rs. 1,27,500; other items being indigo, hides and skins, tea (some of which actually consists of Indian tea imported from Russia), spices, and kerosene oil. The most promising articles of export are carpets, wool, and saffron. An experienced correspondent, writing from the spot to an Indian trade journal, says that merchants, wishing to make a thorough success of their venture, should come prepared to stay and to wait for a year or two, before seeing large returns for their labours. They should gradually extend their business up as far as Birjand, and from there to Turbat-i-Haidari, and so on to Nishapur, Sabzawar, and Shahrud, which are all important centres, doing their buying in Birjand and Meshed. Seistan should be made the headquarters, being both the Customs station, and possessing also a branch of the Imperial Bank of Persia. The same correspondent suggests the establishment of a general stores and a carpet factory, wool being abundant and cheap, and labour very much so. A machine for making soda water and all sorts of sweet drinks, and an ice machine, would be useful adjuncts to the concern, while a couple of carpenters would be found of immense value, and very profitable. The writer adds that, so far as he knows, not a single caravan, of produce of Seistan, has ever before left

Seistan for Persia. Yet in Seistan, goat and sheep skins and cowhides, to the number of at least 300,000. may be bought annually, while wool can be bought at rates that might leave a handsome profit on resale in Meshed and other markets. With regard to skins, a good profit can be made by selling them in Quetta, which, of course, is easily reached by the Nushki route to India, while a still greater profit should be secured if they were sent direct to the consumer. The Seistan trader has, however, but little commercial enterprise, and though the advantages of the direct Nushki route to India are evident, he prefers apparently to obtain the foreign goods through a middleman at the distant port of Bunder Abbas. The carpets produced in the Kainat are of two kinds—(1) those known as Baluch and Bahluli, made by the nomad tribes of those names; and (2) those made by the people of the villages called Drukhshi. The former are invariably small rugs of sombre colours, and the designs are very simple. The average price is about Rs.11 per square yard. The latter are woven on upright looms with a white (English) cotton warp, and a woof of wool. Variegated colours are used, and the designs are numerous and effective. The number of looms has been carefully estimated at 644. The correspondent adds, however, that for English firms desirous of purchasing large quantities of carpets it would be essential to have a reliable agent on the spot. His last remark is significant and important: — "The bulk of this carpet trade, and, in fact, a considerable portion of the export trade, of this part of Persia is in the hands of Russian traders, whose success is mainly due to the operations of the Russian Bank, which are pushed in a methodical and energetic manner. Agents are appointed in all large villages, and are supplied with goods to the value of krans 10,000 (£354) to 50,000 (£1,770) on payment of a deposit of 20 per cent., or more often on a bond executed by two guarantors known to the Bank."

POSTAGE RATES ON SCIENTIFIC PUBLICATIONS.

The Postmaster-General, Mr. Sydney Buxton, M.P., received, on the 12th March, a deputation from the British Science Guild, which asked that the postage rates on publications of scientific and learned, societies might be reduced to the newspaper rates.

The Postmaster-General regretted that he could not accede to the request. He agreed that the circulation of such papers was to the advantage of the country, but he doubted whether to subsidize the societies through the Post Office—for that was what it amounted to—was the best way of benefiting them. The creation of any special rates such as had been suggested would lead to great confusion in the sorting department, where the difficulties were already great. Neither could he grant such reductions of his own accord; it would require legislation to do so, as the rate for newspapers was settled by Act of Parliament-

ARTS AND CRAFTS.

The Lace Exhibition.—The Lace Exhibition at the Royal Horticultural Hall came as rather a surprise, almost a shock, to most people. Everyone at all interested in the arts and crafts movement knew, of course, that a good deal of hand-made lace was being produced in various counties, thanks to home art classes and other agencies, but probably very few people were prepared for the size and importance of the show at Westminster. On the other hand, though we have heard a good deal of recent years about the beauties of, and the improvements in, modern machine-made lace, there has been very little opportunity of looking at it carefully and critically and comparing it quietly with the hand-made work. So that, both from the point of view of manufacture and from that of hand-work, the exhibition was quite unusually attractive, independently of the very interesting loan collection of old laces which was on view in the annexes of the hall.

Point and Pillow Lace.—The hand-made laces shown were practically all English or Irish in type. Outside Ireland, the lace which seems to flourish most generally is undoubtedly "Honiton." The English laces are, as we know, pre-eminently pillow or bobbin laces, whilst in Ireland, in County Cork and elsewhere a good deal of needle point is made. The greater part of the Honiton comes, as would be expected from Devonshire, but the industry, has been introduced in other places, and there is a flourishing association for the supply of this kind of lace at Diss, in Norfolk. The North Bucks Lace Association had a large stall, and exhibited a good deal of the pillow-point lace, "half-stitch," as it is locally termed, for which the county is famous. With this Association is affiliated the Beds. Association, an arrangement which, as preventing undue competition between the adjacent counties, seems to be a movement in the right direction. Some of the work done in competition for the prizes offered, was all that could be desired. Miss A. Trevelyan's piece of Honiton, and one of the pieces of Irish point which received a gold medal, were really beautiful specimens of work. But, when once the few pieces of work to which awards were made, were passed, the level of accomplishment in competition work sank very low. It was really in the lace shown at the various stalls that the main interest of the exhibition centred. Not only was it interesting to see the work of one locality grouped together, but the stalls, representing as they often did, various organisations scattered up and down the country to revive or maintain the hand-made lace industry, formed a very good index to what is being done at present not only in the various English counties, but also in Wales and Ireland. Scotland, by the way, seems practically to confine its energies to machine-made lace—though one competition entry came from Edinburgh.

We naturally associate run and tambour laces with Limerick, but, though some of this kind of lace

came from there, there was a certain proportion of "Limerick lace" included in the exhibits from other parts of Ireland. An exhibit of tambour lace came also from Coggeshall, in Essex, where the industry is said to have been started nearly a century ago by a French refugee.

A very large proportion of the lace now being made, if not actually copied or adopted from existing pieces of old lace, represents the traditional patterns characteristic of particular localities. Some of the modern designs are good, but the various societies seem to find some difficulty in getting hold of really satisfactory designs, and certainly some of the designers have failed to grasp the importance of the distribution of the masses in design for lace, and have not taken advantage of the opportunities which the material so abundantly offers for variety of texture.

Machine and Hand-made Lace.—Hand-made lace-making undoubtedly employs, or partially employs, a very much larger number of people than one would naturally have expected. The societies and associations represented did not all give the number of their workers (it is probably in the case of a cottage industry like this rather difficult to get at), but one county association states that in 1906 it was employing 400 workers, and another industry, run obviously on a smaller scale, has 50 well-trained workers who, we are told, are kept constantly supplied with work.

It is rather depressing to learn that in some parts of the country, at least, twelve shillings a week is considered exceptionally good pay for an excellent worker who works long hours every day. The average wage appears to be much lower than that. It would certainly seem at first sight as if the buyer of machine-made lace were getting a product for the making of which the workwoman had been better paid than the skilled craftswoman who makes the most delicate hand-made lace. If that is so it is a deplorable state of affairs, and one which may well make the thoughtful onlooker wonder whether, beautiful as much of the work is, the production of hand-made lace on a very large scale is altogether to be desired. On the other hand, it has to be taken into account that the girls employed in lace factories live necessarily in towns where the cost of living is higher than in the country—and also that it is difficult to estimate correctly the amount of time spent on work done at home where the worker is liable to all sorts of interruptions, even if she has not the care of a house and family, and so only devotes part of her energies to her trade. Moreover, though it is an argument which is easily pressed too far, there are a fair number of women who need to supplement their income, but who for various reasons cannot go to work at a factory. It is to be hoped that those responsible for the revival of hand-made lace are fully alive to the dangers always incidental to trades of this kind, and will try by combination and every other means in their power to keep the selling price of their wares at a level which will enable them to pay their workers a wage at which it is really worth while working. It is, doubtless, the difficulty of getting a good price for hand-made lace which has made some of the makers of cheap lace buy machine-made braids, which they work up in the needle-point lace. Some of these machine braids are beautifully manufactured, and there seems no reason why they should not be used with needle-point of a fairly coarse kind so long as the resultant lace is not sold as all hand-made.

Another effort in the direction of the combination of hand and machine work, though this dates from the middle of the nineteenth century, is seen in the specimens of silk lace, notably the shawls, made on the old "Pusher" machine. The whole of the pattern was, as it were, woven in the machine (at which stage of its progress the shawl looks like the ghost of the finished product), and then finished by adding a hand-run outline to the pattern in a considerably thicker thread than that employed for the rest of the work. There is a certain fascination about the ghost-like indeterminateness of the half finished work, but it seems perfectly legitimate to finish the machine-made article by hand in this way. Yet another combination of machine and hand-made works occurs in the so-called "Florentine filet lace." This is a kind of machine-made filet lace insertion (usually deep cream in colour), which is finished off by coarse hand embroidery in the same tint. Some of the more ambitious patterns produced by this method are not quite satisfactory, but the simpler ones are in their way all that could be desired, and ought to make very effective trimmings.

Machine-made Lace.—It was, of course, a very severe test for the machine-made lace to see it surrounded by and brought into close comparison with so much good hand-made lace, both old and new, with which it could hardly expect to compare favourably. The one kind of machine-made lace which came out triumphantly from the ordeal was the Torchon. There were some cases of rather coarse imitation Torchon and Cluny lace and insertion which really made one think for the moment that their contents must have been hand-made. It must take away considerably from the pleasure of making this kind of coarse lace by hand to reflect that it can be imitated so extraordinarily well by the machine. Some of the machine-run laces looked very well when they were not examined too closely. One associates this kind of manufactured embroidered lace with the Continent, and it is interesting to see that the same kind of thing can be made, and is being made, at Nottingham.

For the rest, machine-made lace has many uses, not the least being that it fits the pockets of those who cannot afford the hand-made article. A good deal of the imitation lace shown at Westminster was good enough in its way—only, seen in close proximity to the real thing, it very naturally suffered – it was so palpably an imitation that there was no getting away from the fact. At the Royal Horticultural Hall, at

all events, it seemed almost a pity that instead of imitating Alençon, Valenciennes, Brussels, Malines, or whatever it might be, the manufacturers had not spent their energies rather on producing a lace-like fabric which could be readily made by machine and did not quite so definitely compete with the hand-made work.

GENERAL NOTES.

Italians for Australia.—The Italian Minister for Foreign Affairs has forwarded to the Commissioner for Emigration a complete project which originally emanated from the Minister of Agriculture, who, in conjunction with the Australian Government, has formed a plan for the introduction of Italian families as colonists for Western Australia. Mr. Consul-General Nevile-Wolfe in referring to the matter in his report on the trade of South Italy just issued (Cd. 3727-42), says that the scheme contains very favourable conditions not only as to the quality and quantity of land at the disposal of each family, but also in the arrangements to be made with a large agricultural bank, which will finance the peasants during the early years of their venture. The emigrants will pay a small rent for 18 years, at the end of which period they will become owners of the freehold. One hundred families are to be sent out in the first instance, and, if the result is satisfactory, more will follow as soon as possible. Australia has placed only two restrictions, both of which seem reasonable, namely, that the emigrants must be of robust health, and not have been convicted of crime.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

April 29.—"Modern Roumania." By Alfred Stead, Consul-General for Roumania. Sir Percy Sanderson, K.C.M.G., will preside.

May 6.—"The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds." By Lovell N. Reddie.

May 13.—"The Underground Water Supplies of the Thames Basin.,' By Clayton Beadle.

May 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. Martin Duncan.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

April 30.—"Reminiscences of Indian Life." By the Right Hon. Lord Lamington, G.C.M.G., G.C.I.E., late Governor of Bombay.

May 21.—"The United Provinces of Agra and Oudh." By Sir James John Digges La Touche, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

Applied Art Section.

Tuesday evenings, at 8 o'clock :—

April 28.—"Lace as a Modern Industry." By Miss Isemonger. Alan S. Cole, C.B., will preside.

May 26.—

MEETINGS FOR THE ENSUING WEEK.

Monday, April 13...Geographical, University of London, Burlington-gardens, W., 8½ p.m. Dr. W. Bruce, "Explorations on and around Prince Charles Foreland—Spitzbergen."

British Architects, 9, Conduit-street, W., 8 p.m. Paper on "The Design for the London County Hall."

Medical, 11, Chandos-street, W., 8½ p.m.

Entomological, 11, Chandos-street, W., 8 p.m.

Tuesday, April 14...Asiatic, 22, Albemarle-street, W., 4 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p m. Discussion on paper by Messrs. Davis and Kirkpatrick, "The King Edward VII. Bridge, Newcastle-on-Tyne."

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Sir J. Athelstane Baines, "The Peradventures of an Indian Life Table."

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. G. A. Storey, "Art and Photography."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m. Mr. E. A. Bowles, "Hardy Cacti and other Succulents."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Wednesday, April 15...Meteorological, 25, Great George-street, W., 7½ p.m. 1. Mr. Edward Mawley, "Report on the Phenological Observations for 1907." 2. Colonel H. E. Rawson, "The Anti-cyclonic Belt of the Southern Hemisphere."

Geological, Burlington-house, W., 8 p.m. 1. Mr. J. Frederick N. Green, "The Geological Structure of the St. David's Area (Pembrokeshire)." 2. Mr. Leonard V. Dalton, "Notes on the Geology of Burma."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. James Strachan, "Dendritic Growths of Copper Oxide in Paper." 2. Mr. F. Enock, "Nature's Protection of Insect Life," illustrated by Lantern Slides in three-colour photography.

British Archæological Association, 32, Sackville-street, W., 8 p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 3½ p.m. Dr. L. Belleli, "The Assuan and Elephantine Papyri."

In the Report of the Discussion on Mr. Matthews's paper on "Reinforced Concrete," in the *Journal* for March 13th last, page 446, the remarks attributed to Mr. W. A. Berry were really those of Mr. A. B. Geen, and Mr. Geen's speech was reported as having been spoken by Mr. Berry.

Journal of the Royal Society of Arts

No. 2,891. VOL. LVI

FRIDAY, APRIL 17, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

COLONIAL SECTION.

Tuesday afternoon, April 7; The Right Hon. ALFRED LYTTELTON, K.C., M.P., in the chair. The paper read was "The Imperial Problem of Asiatic Immigration." By RICHARD JEBB.

The paper and report of the discussion will be published in the next number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evening, March 31; ALEXANDER FISHER, Hon. A.R.C.A., in the chair.

The SECRETARY of the Section regretted to have to announce that Sir Hubert von Herkomer was unable to preside at the meeting as he was unfortunately suffering from an attack of influenza. He had telegraphed to express his very great regret at being unable to be present. Mr. Alexander Fisher had at short notice kindly consented to take the chair.

The CHAIRMAN said it was unnecessary for him to introduce Mr. Cyril Davenport, as he was well known as a lecturer and writer upon art subjects. He was specially capable of giving some enlightenment upon the question of enamel portraits as he had studied the matter, not only historically, but also technically, and he might say that he (the Chairman) had the pleasure of initiating him into some of the mysteries connected with the subject a few years ago.

The paper read was—

PORTRAIT ENAMELS.

By CYRIL DAVENPORT, F.S.A.

Handicraft is responsible for much that is called art. There is some handicraft in all art, but the proportion varies considerably; in the case of Impressionist painting or chalk drawings there is little handicraft, while in the case of engraved stones—cameos or intaglios—gems—there is a very large amount of handicraft.

In the case of most gems there is nothing at all but handicraft, they do not get beyond it, and whenever art is reached it is very great art indeed. Not only is a fine engraved gem astoundingly difficult to execute long before the art point is reached, but it is also as permanent as any human work can well be. The finest double portraits on cameos are of the third century B.C., and represent Ptolemy Philadelphus with his wife; one of these is at Vienna and the other at St. Petersburg; and the finest single head is Græco-Roman of the first century, a portrait of the Emperor Augustus; it is now at the British Museum. All these are in perfect condition.

Enamels approach gems in the necessity for much handicraft, distinct from technique, and they also share, with gems, a considerable degree of permanence. There are, however, in early enamels, two handicrafts, one of the metal worker, and the other that of the worker in glass, enamel being pounded glass.

Philostratus, who wrote in the third century, mentions enamels, "colours poured on to heated glass," but they were understood long before this time by the Etruscans, about 600 B.C., but only as adjuncts to jewellery, and not as having any portrait possibilities. With the exception of one curious style of work which I must treat by itself, all the early portraits containing enamel were outlined by *cloisons* of metal soldered on to a metal plate, or left projecting from a thick *plaque.* These styles are known either as *cloisonné* or *champlevé* work. Existing *cloisonné* portraits date from the ninth or tenth centuries, and *champlevé* from the twelfth century. The latter are rare.

But in the first century at Rome a very

remarkable application of the fact that thin sheets of metal can be fired on glass was largely utilised. Full accounts of the existing specimens of this kind of portraiture will be found in Garrucci, "Vetri ornati di Figure in Oro. Roma. 1858," and in Vopel, "Die altchristliche gold gläser. Freiburg, 1899," but the exact method of their production is still unknown. There is, however, no difficulty in copying one of these *plaques*, and it can be done in this way. A small disc of clear green glass is covered on one side with a piece of gold foil, fixed either with gum or by a slight red heat. On the gold foil a design is scratched with a sharp point like an etching needle, the dark places being scratched away, and the light places left in the gold. To these drawings small pieces of accruing colour were sometimes added. These colours were undoubtedly metallic oxides; they are dull red, pale blue, white, and green, all opaque, and now and then a little bit of silver foil is also found. When quite finished, a second *plaque* of green glass was fused over the first, enclosing the little picture, and, of course, preserving it perfectly so long as the enclosing glass remain. The surfaces of the glass discs are often enough roughened by time and usage, and now and then the whole thing is broken; but I think these gold-glass *plaques* may be considered as the earliest portrait enamels now left. I consider these gold-glasses to be very important to modern workers in enamel, and it is possible that a careful study of them might suggest new methods of procedure with regard to the placing of outlines and accessories as an enamelled *plaque*.

One other method of producing pictures in enamel was practised in the fourteenth, fifteenth, and sixteenth centuries. But I have not found any actual portraits done in this way. It is known as "Basse Taille," and is generally done on gold or silver. The design was cut in low relief, like some of the Egyptian sculptures on walls of temples or on rocks. Then enamel colour was fused into the sunken places, the colour appearing deeper or fainter in accordance with the depth or shallowness of the engraved work.

The finest example of this work in England is the St. Agnes Cup in the British Museum. It is of gold, and on the lid, sides and foot are beautiful *basse-taille* enamels, representing scenes in the life of St. Agnes. It belonged to Charles VI. of France, and afterwards to Henry VI. of England, and is now in the British Museum. It is probably French work.

The oldest portraits in colour are, I believe, encaustic portraits which have been found in later mummies, and in the cemeteries of the Fayum in Egypt. They date from about the second or third centuries A.D. As a rule they are not well preserved as the wax has become hard and brittle, and easily cracks off. Pliny describes these wax pictures at some length, and there are some good examples of them at the National Gallery, and also at the British Museum.

From the Fayum also come several *plaques* of wood painted in distemper, permanent as to colour, but very easily chipped, as chalk or white clay is mixed with all the pigments. Such paintings are also described by Pliny.

The names of the early enamellers are unknown, but in the sixteenth century there are several, mostly belonging to the Limoges school. The two greatest portrait enamellers of past times have been Léonard Limousin, in the sixteenth century, and Jean Petitot, in the seventeenth; and each of these masters invented a process for himself, and had a large number of followers; but Petitot has now the larger following of the two. His method and style is, however, not so fine as that of Limousin. It is easier to make an enamel in Petitot's manner than it is to make one in the manner of Limousin. But the Petitot copy is nearly sure to be very bad, whereas the copy of Limousin may be quite passable.

Léonard Limousin began by making copies in enamel of contemporary engravings. In 1532 he copied Albert Dürer, in 1535 the "History of Psyche," engraved by the "Master of the Die," after Raphael. Presently he became attached to the French Court and came under the influence of the masters of the school of Fontainebleau. In 1545 he made twelve enamels of the Apostles for the chapel of the Chateau of Anet, after Michel Rochetel. In 1548 he became "Valet de Chambre and Emailleur du Roi," and in 1553 he made enamels for the back of the altar at the Sainte Chapelle, after Nicolò dell' Abate. He worked both in grisaille and in colour, but his work as a portrait painter in enamels is by far the most important work he did. He belonged to the finest period of enamelling at Limoges (c. 1530-1580.) Léonard's relatives, Jean, Léonard, Joseph, and François, and Susanne Court all belonged to the next period, the Minute, as it was called by Sir Wollaston Franks, and their work is not

to be compared with that of the preceding enameller. To this decadent period belong the enamellers of the family of Landin, who often painted small faces, usually with black backgrounds.

Jean Petitot was born at Geneva, 12th July, 1607, and at an early age became an apprentice at a jeweller's and goldsmith. He was apprenticed to Pierre Bordier, who quickly became his friend.

Petitot wrote a little MS. book of "Prières et Meditations Chrestiennes pour la Famille" in 1674, and a long and excellent account of him and his work will be found in M. Ernest Stroehlin's book on "Jean Petitot et Jaques Bordier, Deux Artistes Huguenots du XVIIme. Siècle."

Petitot was especially fond of enamel work jewellery, applied either in the *cloisonné* or the *champlevé* manner, and he soon became expert in the management of these processes, and in order to increase his knowledge, Bordier generously shut up his workshops at Geneva and took Petitot on a tour of inspection all about France, and more particularly to Limoges, where the Huguenot masters, Jean Penicaud, Léonard Limousin, and Bernard Palissy were held in the highest esteem. At Chateaudun, about 1632, they came across Jean Toutin, the Royal jeweller.

Toutin seems to have been the first enameller to use enamel paints; his colours are dull, but the process he used appears to be the same as that used now, the colours ground very fine, diluted with oil of lavender or turpentine and applied with a very fine brush in the stippled or dotted manner, like an ivory miniature. Such enamels seem to have been made about 1630, and from that time until now there has been a large amount of this enamel-miniature work done both on metal and on china. Petitot got his first ideas on miniature work from Toutin, and he very soon surpassed his master in the beauty of his work.

The travellers now crossed over to England, attracted by the art reputation of Charles I. The King presently saw some of their work, and being much struck with it, sent for them, and ordered his own portrait to be done in the new manner, and also others of members of his family. A workshop was set up at Whitehall, and Petitot was made acquainted with Van Dyck and the King's doctor, Turquet de Mayerne. Mayerne was a Huguenot, who had been Court doctor to James I.; he was a remarkable man, and a great experimental chemist, and it was, doubtless, largely due to his help that Petitot was enabled to get the wonderful colouring he did. Petitot executed a celebrated enamel of Rachel de Ruvigny, Countess of Southampton, after one of Vandyck's pictures. It is now at Chatsworth, measuring $9\frac{3}{4}$ by $3\frac{3}{4}$ inches, and was much admired by Walpole, who says it is the finest enamel in the world.

On the death of Charles I., Petitot returned to France, but Pierre Bordier remained in England, and made some well-known enamels, one of Parliament and one of the Battle of Naseby. Horace Walpole says these little enamels were an inch and a half in size, and that "nothing more perfect could be imagined."

In Paris, Petitot met Jaques Bordier, a cousin of Pierre, and also an enameller. Petitot had an introduction to Louis XIV. from Charles II., and both he and Bordier were given apartments in the Royal Palace and made Court painters. There is a tradition which says that Petitot painted the faces, and flesh colours generally, but that the hair, dresses and accessories generally were done by Bordier.

Richelet in his "Remarques Préliminaires," Paris, 1680, says that MM. Bordier and Petitot are the most famous painters in enamel in Paris, and the first who have made portraits in enamel; before then there were only flowers and prettiness; "the enamel is done on plates of gold or copper covered with white enamel." Sometimes the enamels were after original sketches, and sometimes after portraits by contemporary artists, Lebrun, Mignard, Rigaud, Nanteuil, Philippe de Champagne, Largillière, &c.

Petitot's enamel portraits are, as a rule, on gold, covered with a pure white enamel ground, and on this the colours are laid with a marvellous delicacy and minuteness of execution. They fire as painted, touch for touch, with very slight changes of colour, but their surfaces are different from those of the true vitreous enamels. The school of enamelling projected by Petitot had an immense vogue abroad in the latter part of the seventeenth century, and the earlier part of the eighteenth. Both Dutch and French jewellers gladly made use of the new and beautiful art for the decoration of watch cases, among the most successful of them may be mentioned Jan Berninck, of Amsterdam; Jean Hebrat, of Brussels; Gribelin, of Paris; and Huard le Puisné. The work of the English enameller, J. Tompion, of

London, is also found on watch cases. His flesh tints are pleasing.

A large number of miniature painters followed the same style in England. At first, these miniature enamellers were mainly foreigners. Charles Boit, a Swede, worked successfully here, but his work is still rare. He made portraits of Queen Anne, and many of her Court circle. Among his pupils was Charles Zincke, a German, who afterwards became a far better enameller than his master. He made several enamels after Sir Peter Lely; many of his enamels are of a large size, like those of Léonard Limousin.

Charles Muss was an Italian, and his work was popular, and good. He was "painter in enamel" to George III.

Gervase Spencer was an English miniature painter, but his name is better known as an enameller. He was the first English artist to make portraits in the Petitot manner.

Michael Moser was an original member of the Royal Academy, and an excellent worker in enamels.

Nathaniel Hone, an Irishman, was an oil painter, and also an original member of the Royal Academy. He succeeded better in enamel work than in oils; and so did his son, Horace.

John Plott studied under Nathaniel Hone. He was a miniature painter who practised enamelling probably only with the motive of studying the effect of possible colours.

Jeremiah Meyer was an original member of the Royal Academy. He was a German and a pupil of Zincke. As a miniaturist Meyer's work does not appear to have attracted much attention, but as an enameller he held the appointment of enameller to George III.

Pierre Adolph Hall, a Swede, and one of the finest miniature painters on ivory, worked a little in enamel. Hall was a great colourist, and no doubt the beauty of enamel colours attracted him strongly, but the technical difficulties and the uncertainty of the final results prevented his making any extended use of the process.

Henry Spicer was a pupil of Gervase Spencer, and was enameller to George Prince of Wales, afterwards George IV.

Richard Crosse, the deaf and dumb miniaturist, was "enamel painter" to George III. His enamel work is rare.

George Engleheart, one of the greatest of English miniaturists, painted sometimes in enamels, probably wishing to try some method of producing work which would not fade rapidly. But Engleheart never did much enamelling, and his work in this medium was mostly experimental.

Henry Bone, a member of the Royal Academy, was one of the best known English enamellers. He began life as a china painter, and learnt many valuable secrets as to the fusible colours used in that art. Bone worked very hard in the endeavour to formulate rules by which definite colours might be safely produced, and in this he succeeded to a great extent. But the early mannerisms of the china painter always show in his work. Bone was enameller to George III., George IV., and William IV., and his enamels, large and brilliant, are much sought after and will probably increase in value, but never to any extravagant extent. His work is mostly that of a copyist. One of his most pleasing examples is now in the Hertford House collection; it is a copy of the portrait of Mary Queen of Scots, now at Hatfield.

Henry Pierce Bone, enamel painter to Queen Adelaide and Queen Victoria, continued his father's tradition, and his work is of about equal value.

William Essex also made copies in enamel for pictures—portraits as a rule. His work is stronger than Bone's, and has not the "china painting" quality so strongly marked. Essex made several discoveries as to enamel colours, and I believe that many of his secrets are still kept among the professional enamellers. Essex was "Painter in enamels" to Queen Victoria.

Some few years ago a French enameller, Dalpeyrat, came to England and held classes here. To these classes many artists whose names are now well-known came and profited, and to-day we have several enamellers who are able to make portraits in enamels.

I do not think that there is any fixed method of executing such portraits, every enameller gets his effect in his own way, but there seems to be a general consensus of opinion that the principle used by Léonard Limousin is really the soundest. That is to say, for flesh colour, it is best to lay down a dark ground, over that to lay thick white in varying thicknesses, and on that again to lay pink and yellow as well as possible. The remainder of the enamel may be all done in transparent enamels. Flesh is not transparent, and any representation of flesh executed in transparent colour only, must, I think, be wrong. Semi-transparent glazes of yellow and pink can be applied to a white base by the help of colours finely ground

mixed with a volatile oil, and I imagine that in this manner a reliable flesh colour can most easily be obtained. It is, however, certain that success may be obtained once, and the next time, although apparently everything has been done in exactly the same way, the plate may be a failure

Some of the foremost enamellers of the present day in England have done much in the matter of flesh colour. I imagine that Sir Hubert von Herkomer has studied this particular problem more closely than any other enameller, and in many instances he has acheived remarkable success. I think he will live longer by reason of his enamel work than by any of the many art processes in which he is a past master.

We have fortunately often had the pleasure of admiring at the Royal Academy, beautiful translucent enamel portraits made by Mr. Alexander Fisher, and set in delightful frames also made by himself.

Mrs. Hart Partridge is very successful in minute portrait enamels, many of which are remarkable for the admirable treatment of flesh colour.

The Royal Society of Arts have been able to get together from these artists and others a small but important collection of portrait enamels, and I hope that this little exhibition will form a new starting point in the history of this beautiful and little-known method of portrait painting, not only charming in colour and form, but, if not accidently destroyed, possessing the inestimable advantage of remaining unimpaired for thousands of years.

I find that the Society of Arts offered in the eighteenth century premiums for "Historical Painting in Enamel," a composition of three human figures at least, on a plate not less than 3 inches by 2½ inches. In 1764 John Finlayson received 15 guineas, and in 1765 Charles Handasyde 10 guineas. In 1768 John Donaldson received 20 guineas, and afterwards 30 guineas, and Charles Handasyde again 30 guineas.

LIST OF SLIDES.

Except when otherwise stated, the examples from which these slides were made are in the British Museum, the Victoria and Albert Museum, or the Ashmolean Museum, at Oxford.

1. Roman gold-glass of the second centuiy, showing portraits of bride and bridegroom.
2. The Dowgate-hill brooch, with *cloisonné* enamel portrait of a king, ninth or tenth century. Anglo-Saxon work.
3. The Alfred jewel, with *cloisonné* enamel portrait of a man. Anglo-Saxon work.
4. Anglo-Saxon brooch, with *cloisonné* enamel portrait of a lady.
5. Byzantine *cloisonné* enamel head of Christ, lettered in niello.
6. The crown of Constantine Monomachos, with *cloisonné* enamel portraits of the Emperor and Empresses, Zoë and Theodora. Eleventh century work. At Buda-Pest.
7. Full length *cloisonné* enamel portrait of the Empress Irene, wife of Alexis Comnenus I. Lettered in niello in Greek. From the Pal d'Oro, at Venice. Byzantine work.
8. Full length *cloisonné* enamel portrait of the Emperor Ordelafo Faliero. Ancient Byzantine enamel lettered anew in niello. From the Pal d'Oro, at Venice.
9. Limoges *champlevé* enamel with figures of the Virgin Mary and St. John. Twelfth century work.
10. Italian silver plaque, engraved in the *basse-taille* manner, the enamel having all broken away. Fifteenth century work.
11. The St. Agnes cup of gold, with *baisse-taille* enamels. Fourteenth century French work.
12. Italian painted plaque of the fifteenth century, showing a profile head of Ceres in white on a translucent red background.
13. Limoges *grisaille* dish, painted by Pierre Courtois about 1560, showing white flesh colour with very light red.
14. Holy Family; enamelled Limoges plaque, painted by Nardon Penicaud, about 1503, showing purple tinge in the faces.
15. The Annunciation; enamelled Limoges plaque, painted by Jean Penicaud about 1540, showing white flesh with slight red tinge.
16. Profile head of Christ, painted by Jean Penicaud at Limoges about 1550. White flesh with very little pale red.
17. "Sybilla Europa;" half-length figure enamelled plaque, painted by Léonard Limousin about 1550. One of a set of twelve Sybils.
18. Portrait of Charles Tiercelin, Chancellor of France. Enamelled plaque by Léonard Limousin, with brilliant blue background.
19. Bust portrait of Jeanne de Genouillac, by Léonard Limousin, 1550.
20. Bust portrait of Francis I., by Léonard Limousin, 1550.
21. Lady, with a rose. Small miniature ename plaque, painted by Jean Toutin, 1851.

Miniature Enamels, by Jean Petitot :—

22. Christina, Queen of Sweden.
23. Anne of Austria, Queen of Louis XIII.
24. Marie Louise d'Orléans.

25. Mad. de la Vallière.
26. Ninon de l'Enclos.
27. The Marquise de Maintenon.
28. The Duchesse d'Aiguillon.
29. Lady, in a yellow dress.
30. Louis XIV., as a boy.
31. Louis XIV., as a young man.
32. Louis XIV., as a man of middle age.
33. Cardinal Richelieu.
34. Henri, Duc de Guise.
35. Louis, Duc de Guise.
36. The Duc de Luxembourg.
37. The Duc de Vendome.
38. The Duc de Berri.
39. The Duc de la Rochefoucauld.
40. The Vicomte de Turenne.
41. Nicolas Fouquet.
42. French watch back, with sylvan scene. Painted by B. Foucher, of Blois, about 1635.
43. Purse, with enamelled bust of a lady. Painted by J. Landin, about 1690. Lustrous black background.
44. English enamelled watch-case with Virgin and Child. Painted by T. Tompion, about 1770.
45. Portrait of Joseph Addison, enamelled by C. F. Zincke, about 1680.
46. Man in a blue coat. Enamelled by Gervase Spencer in 1749.
47. "Sarah, Duchess of Marlborough;" after Kneller. Enamelled by H. P. Bone.
48. George IV. Enamelled by W. Essex, about 1825.
49. Admiral Viscount Nelson; after Abbot. Enamelled by W. Essex, 1847.

Actual Enamels Exhibited on the Table.

Exhibited by the artist, Sir Hubert von Herkomer, C.V.O., R.A.

1. Prof. H. von Herkomer.

Exhibited by the artist, Mr. Alexander Fisher (Chairman):—

2. Lady Elcho.
3. Marchioness of Sorano née Italia Blair.
4. Veronica Noble, daughter of Major George Noble.
5. Sylvia Fisher, daughter of Alexander Fisher.
6. The Earl of Portsmouth.
7, 8, and 9. Three small enamel portraits, exhibited by the artist, Mrs. Hart Partridge.
10. Dorothy Davenport, exhibited by the artist, Mr. Cyril Davenport.
11. Portrait of a child gathering flowers, by Miss N. Brightwell. Exhibited by Mr. Cyril Davenport.
12. Mrs. Witherspoon, miniature exhibited by the artist, Mr. H. R. Witherspoon.
13. Coat of arms, showing a vermilion red, exhibited by the artist, Mr. W. Mark.

DISCUSSION.

The Chairman (Mr. Alexander Fisher), in opening the discussion, said that Mr. Davenport's most interesting paper had been illustrated by a remarkable series of slides which covered a very wide range —from the first century up to the time of Petitot—which was a very far cry. The earlier specimens were so primitive that they could scarcely be called portraits at all; indeed, the first slide in his opinion was not an enamel portrait, but looked more like glass covered with a bit of foil and then scratched through. Enamel consisted of a vitreous compound laid upon metal, and not metal laid upon the vitreous compound. He thought portraiture really consisted in how much the artist saw, and with what accuracy and correctness he saw it. If the subject was a beautiful lady, the artist should take the finest possible view of her and record it in the most beautiful manner possible, and enamel was the finest material of all in which to express this quality. When he commenced to do portraits in enamel, he found it was exceedingly difficult to choose a very definite standpoint. The first portrait he was asked to do was that of the late Earl of Warwick, the request coming from the Dowager Countess; and he did that portrait in white enamel upon a blue ground, from little sketches that were supplied to him. He found at the commencement that enamel was one of the most difficult mediums in which to do portraits, but, at all events, the Dowager Countess was very well satisfied with the result, and the portrait was, he believed, the first thing of its kind that had been exhibited at the Academy for a very considerable time, marking the revival of enamel portraiture in England. The next portrait he did, that of Lady Elcho, was a very great advance on the portrait of the late Earl of Warwick, because there he essayed to introduce colour into the flesh. He proceeded much upon the lines of Léonard Limousin, only instead of starting with a dark ground, working upon it with white enamel, and then delicately tinting it here and there, such as on the lips, the eyes, and the eyebrows, he went in for a little more modulation and, as he thought, a greater delicacy; but still he kept to a very definite decorative sort of treatment of his subject. After that he essayed to go a little further, and in the portrait of the Earl of Portsmouth it would be noticed that he had abandoned the profile, and turned the face almost three-quarters. He had avoided an excessive amount of light and shade, which he had a natural inclination to do, because he thought it was apt to give a distinctly photographic look to the picture, which he thought was not a pleasant thing in enamel. He noticed very often that even Petitot's beautiful miniatures, which are not true enamels, but paintings upon enamels in freed oxides, suffered from an excessive amount of shadow in the face. He (the Chairman) had exhibited a miniature of his baby, in which he had thoroughly let himself go as to the treatment, doing a painting

exactly as he saw the child, endeavouring to give a most realistic picture, but at the same time keeping all the precious qualities of enamel steadily in view.

Mr. Lewis Foreman Day said that he really did not wish to say anything at all on the subject, because he had nothing to do with portrait painting, and because he thought at the bottom of his heart that enamelling was by no means the best way of producing portraits. But, as he had been called upon to speak he would like to ask the Chairman whether he regarded enamels as a very good means of expressing oneself in portraiture? It seemed to him that the quality of enamel was colour, and the kind of colour for which portraiture gave the artist no chance. The kind of colour that a portrait demanded was very difficult indeed to get in enamel. He should have thought that enamel was about the most stubborn and difficult thing in which to get the qualities of flesh. The old men to whom the author alluded evaded the difficulty very largely by not attempting the quality of flesh colour at all. Admirable as Léonard Limousin's work was in many ways, it did not give the quality of flesh, the portraits really being tinted drawings, and they had not the charm of colour which much inferior men obtained when they were trying only to do what vitreous colour could do best. He had hardly thought that such colour could be obtained as the Chairman had arrived at in some of his work; but he was bold enough to say that he thought Mr. Fisher would probably have produced still finer colour if he had worked in some other medium. He would like to know whether the Chairman really thought that enamel gave him the opportunity of doing all he knew in flesh colour, because personally he should not have thought it possible. It seemed to him that the real beauty of colour was in what Mr. Davenport called the accessory colour in the draperies and the backgrounds, where the full quality of enamel was obtained, but in the flesh he thought the medium was not all that a colourist could desire as a means of expressing himself. Those remarks applied equally to Petitot's and other artists' work. He quite agreed with the Chairman that the first slide was not an enamel in any sense of the word. Mr. Davenport had said that he did not know of any early portraits in enamel, but he thought he must have overlooked one of the very earliest portraits, the well-known grave plate of Geoffrey Plantagenet, which was entirely *champlevé*. The obvious reason of the nasty purple effect which ran through the enamel in Penicaud's work was the manganese with which it was painted, which was the most treacherous material in the world, and nearly always gave that nasty colour. In thanking Mr. Davenport for his interesting paper and the excellent slides he had shown, he knew the author would not mind his saying that he thought enamel was inappropriate for portraiture in its highest form. It had, however, the justification that enamel was the goldsmith's way of getting colour; and if portraits were desired in goldsmiths' work, enamelling was the proper way to get them. But he agreed with the Chairman, that it was better to keep the work rather decorative, and not to attempt all that a painter would do if he were not tied down to such a rigid and difficult material as enamel.

Mr. Cyril Davenport said he omitted to say with regard to the little gold glasses and the effects obtained, that in a very great number of instances colour was put upon them. It was a very low colour, such as blue, green, white, dull red, pale blue, and white and green, all opaque. They were undoubtedly oxides, and there was very little doubt indeed that they might properly be called enamel colours. In regard to what Mr. Fisher said about the gold having been fixed on the glass, the glass also was fixed over the gold; but he thought the fact of those colours existing made a certain amount of difference in the judgment as to whether they were enamel or not.

Mr. Halsey Ricardo thought it was extremely desirable that a great quantity of portraiture should be produced which was within the reach of ordinary persons to command. A person of importance and money could always have his portrait painted in oils; there had been a revival to some extent of portraits being done as miniatures, and he was glad to see that the possibility of having portraits done in enamel was now open to those who desired it. An obvious answer to his difficulty seemed to be that an individual could go and be photographed, but a photograph was not a portrait. In the Daguerreotype days, the sitting was a matter of a minute or more, and the camera then managed to get a record which contained some history of the face it was attempting to portray; but with the present improved methods of instantaneous photography, a lightning-struck effect was obtained which had only a momentary likeness of the person photographed. It was an intense gratification to be able to go to the National Portrait Gallery and see any number of portraits, even though some of them were badly done, because then one was able to form, at any rate, some sort of mental picture of the individual whose portrait had been painted. He thought all forms of portraiture were to be welcomed, and from that point of view heartily congratulated Mr. Davenport on his paper.

Mr. Charles Welch said it afforded him very great satisfaction to be present and listen to a paper on a subject of so much interest, and of which he would carry away very pleasant recollections. He heartily congratulated Mr. Davenport upon his magnificent slides, which must have involved a large amount of patient work in order to reproduce so admirably such exceedingly small and beautiful objects.

Mr. H. R. Witherspoon, speaking as a student, said he could not help feeling that the colouring of the slides did not convey all the beauty of the originals.

Mr. Carmichael Thomas thought that when Mr Day asked if enamel was suitable for portraiture, he could not have been looking at the beautiful portrait in enamel of a lady which had been right in front of him all the evening.

Mr. D. Macnaughtan enquired whether the Chairman experienced much difficulty in getting the oxides to adhere to the metal.

The Chairman replied that oxides were a component part of enamel. In themselves they would not adhere to metal surfaces, but only when mixed with enamel. Oxides were colouring agencies of enamels, but not the enamels themselves. The base of enamel was silica, with the addition of minium and potash; and that base, which gave a clear, colourless form of glass, was coloured by means of various oxides. The enamel came out in a sheet of glass, which was pounded up into a powder, then spread upon the metal and put into a furnace, and it then fused into a thin sheet of glass over the metal, which adhered to it. Mr. Davenport's splendid slides gave a very good idea of enamels generally. He thought Mr. Davenport would forgive him if he said that the examples of Petitot, with perhaps one or two exceptions, should remain as miniatures; they were so wonderful as miniatures that they did not seem to bear enlargement. It was very kind of Mr. Day to take the other side of the question, because an artist wanted a little antagonism to brace him up. In all such things it was a question of the success justifying the treatment, and success made its own laws. He did not regard the imitative quality as being of the utmost importance. Whether the enamel was like flesh or not did not matter so very much; it was a question of how much one wished to see in a portrait. For instance, an artist might do an excellent portrait in a *grisaille* with just a dark line round it, like Léonard Limousin did, who was practically a painter of that class, but he was not a real enameller as one understood the expression to-day. The amount that Léonard Limousin knew was a very minute part of the subject, although he (the Chairman) admitted that he had produced some very beautiful decorative portraits, and was one of the greatest artists in his way that had ever lived. Still, one had to bear in mind that Limousin did his utmost to make the portrait look like the person. There was in the Louvre a portrait of François II., by Limousin, in which the modelling of the face was very elaborate, and the colouring was carried very much farther than in any other work that he did. The only drawback, however, was that he used very inferior enamels, although he used the best that he could possibly get at the time. The present love for antiquity and antiquarian things had created a taste for them, until artists began to look at all the faults and defects in old men's work with a certain amount of love and affection which they would not stand in each other's work at the present day for a single moment. Among the exhibits was a wonderful specimen of enamel work, made by Sir Hubert von Herkomer of a most lifelike portrait of himself, which was a perfectly amazing piece of enamelling, although for his (the Chairman's) taste it was carried a little too far, being more in the nature of an oil painting. Nevertheless, it was impossible to withhold a tribute of admiration for the capability that it displayed in a difficult medium. Everyone agreed as to the difficulty of working with enamel, but it was quite an erroneous idea that it was a rigid, inflexible material, it being one of the most fluid, facile mediums in certain respects which could possibly be used. The origin of *cloisonné* and *champlevé* enamels was simply that the old men had been in the habit of setting stones with a wire setting, and they thought that enamel had to be treated in the same way. Since then almost everybody had said that enamel must be set in a *cloison*, and must have a boundary wall of metal, otherwise it would flow with the heat all over the place, whereas, as a matter of fact, the artist could do just what he liked with it. In conclusion, he desired to propose a very hearty vote of thanks to Mr. Davenport for his exceedingly interesting paper.

The resolution of thanks having been carried unanimously,

Mr. Davenport, in reply, said that he hoped those present would take the opportunity of carefully inspecting the specimens which were exhibited because it was very unlikely they would ever have an opportunity again of seeing such a fine collection of English portraiture in enamels. In the first place, he wished them particularly to notice Sir Hubert von Herkomer's wonderful portrait of himself, which was known all over the world. The Chairman's portraits also were splendid in colour, and excellent portraits also. He could not help agreeing with Mr. Carmichael Thomas when he said that Mr. Day had only to look at the beautiful lady in enamel in front of him to see that enamel was a magnificent material for portrait painting, although it was a slow process, and required enormous patience. He congratulated the Chairman very much indeed upon the magnificent collection he had been able to lend for exhibition; and he also thanked the Society for the opportunity they had given him of bringing such an important question forward, and for the admirable way in which the slides had been shown.

DETERIORATION OF PAINT.

In connection with the subject of Mr. A. S. Jennings's paper on "Recent Improvements in Decorators' Materials," read before the Royal Society of Arts on March 25th (see *ante*, p. 509), the following letter on the deleterious influences of hot and moist climates on paint is reprinted from *The Colonial Office Journal* for April.

"We have experienced great trouble with paint on the Gold Coast. In many cases paint, both sent out ready mixed, and also that mixed locally, has turned black in a few weeks. During the last eighteen months some sage green paint, used at Kumasi, turned black, being covered with a black mould. Several other bungalows at Tarkwa, Sekondi, and Accra, were painted, with similar results. The exterior paintwork suffers more than the internal, and the walls of rooms which are more exposed to the wind suffer most.

"An addition was made to Sekondi Hospital recently, and the interior of one of the wards painted some light colour. A curious growth was observed, not exactly a growth of a sooty character, but more like small black stalks or fibres projecting at right angles to the surface of the wood. The wood came from England (pitch pine). I did not send home a sample of this as I could not make certain when all the constituents of the paint were received in the Colony.

"At Accra, this black growth is not noticed to the same extent as at the out-stations, probably due to the fact that Accra is very much drier. My bungalow was painted in 1904, and is still in fair condition. In some cases the black growth can be washed off, but leaves the paint underneath discoloured, and it soon reappears. Torbay paints do not appear to be affected so badly. In Sierra Leone, I did not notice the same defect in the paint, and though some of it did not stand well it was much better than the paint on the Gold Coast. Paintwork is, at present, so unsatisfactory, that I think a combined enquiry, or investigation, carried out in all the West African Colonies, and possibly some others, might produce some useful result."

The editor of *The Colonial Office Journal* adds: "Speaking generally, the paints used should be zinc oxide, as lead oxidises quickly."

TRADE WITH SWITZERLAND.

In his report on the trade of Switzerland, just issued (Cd. 3727-44), Mr. Vice-Consul Milligan again directs attention to the great discrepancy between the value of the exports of Swiss goods to the United Kingdom and that of British exports to Switzerland. The United Kingdom has long been the principal purchaser of Swiss manufactures. She purchases more of Swiss silk and leather goods, chocolate, and condensed milk, than any other country, British purchases in these four branches alone amounting to upwards of £4,000,000. But British exports of manufactures to Switzerland only amount to 13 per cent. of the whole. While Switzerland sent us her manufactures to the value of £7,057,000, we were only able to sell her our finished goods to the amount of £2,552,000, thus showing a difference of £4,505,000 in favour of Swiss industry in the trade relations between the two countries. In Mr. Milligan's opinion, British commercial travellers might with advantage direct greater attention to the Swiss market than is the case at present. There are many classes of goods, such as finished leather goods, leather gloves, cutlery, gold and silver ware, woven carpets, porcelain and china goods, woollen, linen, and other ready made goods, forged iron goods, copper and brass goods, superior pottery, and note-paper and envelopes in boxes, in which a large trade could be done by British wholesale merchants and traders. But in order to effect that it would be necessary to arrange for stocks to be kept in the country. As a rule, Swiss retailers, and even wholesale dealers, do not care to place large orders a long time ahead, but prefer to buy as required from an agent or representative who keeps a store, and who can supply them with what they require by return. Switzerland is a small country, but despite an increased tariff, and its own manufacturing capacity, it was able to purchase, in 1906, finished goods, exclusive of cotton goods, to the value of £17,000,000, and of this the United Kingdom supplied only to the value of £863,500.

LIBRARIES IN INDIA.

A suggestive return has just been prepared in the Home Department of the Government of India showing the statistics and other information relating to the principal libraries in the various presidencies and provinces of India. It appears that the highest numbers are found in Bengal (139), Madras (86), Bombay (61), and Eastern Bengal and Assam (55). The grand totals about 419. The locality, number of volumes, annual expenditure on books, specialty, to whom the library is open, and existence or absence of a catalogue, are all points regarding which information is given in tabular form. It would be interesting if some attempt were made to enlarge the return in future years, and explain what is the approximate attendance, what classes of readers frequent the libraries, and what benefits would appear to be fairly traceable to such educational adjuncts. The numbers are of course rather insignificant compared with Western countries, but the published list may suggest and bring about the extension of so desirable a movement.

HOME INDUSTRIES.

Lottery Tickets in Cotton Bales.—A circular has been addressed by the Hong Kong Chamber of Commerce to various other Chambers in Great Britain and elsewhere directing attention to a remarkable proposal of the Japan Cotton Spinners' Association, namely, that Japanese cotton yarn should be made attractive by inserting lottery tickets in the bales, and so appealing to the gambling instincts of the Chinese buyers. The Hong Kong Chamber proposes diplomatic action, and the Chinese authorities threaten a prosecution of the merchants who buy the yarn. Whatever is possible will no doubt be done to checkmate the objectionable procedure recommended by the Japanese Cotton Spinners' Association. The large trade in yarn done by India with China might be endangered if this lottery system was allowed to go on unchecked, and it is said that Lancashire trade has already been affected by it. The Government may be relied upon to take all possible steps when the Chambers of Commerce have satisfied it that the matter is really one of serious moment. In another direction Japanese traders are reminding our own that they have to reckon with the rivalry not only of ingenious but of rather unscrupulous competitors. Japanese piracy of British trade marks has become very frequent. The British Ambassador in China is said to have suggested to his Government that British manufacturers should "start entirely new trade marks." It is difficult to believe that this recommendation has really been made, although the statement comes from the Shanghai correspondent of the *Times*, and still more difficult to suppose that it would commend itself to the Government.

The Glazed Brick Trade.—A powerful combination in this trade has been formed, and it is understood that a new uniform price list will be issued to customers. *The Manchester Guardian* has authority for stating that a material advance in the low prices prevailing is contemplated, and that the combination embraces the whole trade. About £1,000 is to be put down by the signatories as earnest money, and by the end of the year probably £15,000 will have been deposited as security for the due maintenance of prices. The unremunerative state of the trade has been shown plainly by the annual report of the Leeds Fireclay Company, Limited, as well as by the financial results of smaller concerns. Makers of glazed bricks consider themselves to have been the worst sufferers from the depression in the building trade.

Light Flax Fabrics.—A remarkable feature of the recent linen trade boom was the demand for light flax fabrics, such as lawns and sheers. The demand was so great that it became necessary for buyers not only to pay fancy prices, but to use pressure to obtain deliveries. Spinning mills found it difficult to keep pace with the demand for the fine leas necessary for making these goods, and in many factories a large section of looms might have been seen idle for days at a time waiting for yarns. As a necessary consequence of this state of things many manufacturers placed their orders for fine yarns so far ahead that spinners became oversold as far as they would go. So with shippers with regard to orders for cloth, more especially American dry goods importers. Then came the American financial panic. Manufacturers had long lists of unexecuted orders on their books which began to be cancelled on the score of late delivery, followed by requests for postponement of shipments indefinitely, or wholesale reductions in contract prices, and not a few importers took advantage of the panic to cancel all their commitments in linen lawns. The effect is seen in tumbling prices. Within the last few weeks they have fallen from 25 to 30 per cent. below the rates ruling last October, and many small lots are changing hands at an average loss to the seller of 17s. to 25s. per piece of 80 yards.

The Port of London Scheme.—The text of the Port of London Bill has now been issued, and perhaps the most obvious criticism is that it ignores the great Thames wharves. These wharves are a very important feature of the Port of London, and are essential to the great transhipment trade. It is to be hoped that competition will not be engendered between them and the docks owned by the Port Authority, which might well affect the revenue of that Authority. One noticeable feature of the Bill is the considerable authority reserved to the Board of Trade. It will not only have two representatives on the new London authority, it will have power to make orders authorising the Port Authority to purchase land compulsorily, without resort to Parliament, to impose charges in respect of new works, and to vary the qualifications of voters. It will also appoint the first chairman, and determine the amount of his salary, and the auditor of the accounts of the Port Authority. Should it be satisfied at any time that a deficiency is probable, it will have power to require the Port Authority to levy additional dues up to the statutory maximum. And as it will not be possible to frame a register in time for the first election, the Board will, after consulting "persons and bodies with experience in connection with the port," appoint the members in place of those who would otherwise have been elected had there been a register. The elections of elected members are to be held "at such times and in such manner and in accordance with such regulations as the Board of Trade may by order direct."

The Shipbuilding Industry.—"Lloyd's Register" for the past quarter gives striking proof of the depression in the shipbuilding industry. Excluding war ships, there were 415 vessels, of 847,501 tons gross, under construction in the United Kingdom, on March 31st, as compared with 585 vessels of

1,306,087 tons a year ago. The tonnage now under construction is 101,000 less than that which was in hand at the end of December, and 459,000 less than that building thirteen months ago. Not since September, 1884, has there been an equal decrease in the shipbuilding industry during a year. In September, 1884, the decrease was slightly larger, namely, 469,000 tons as compared with the corresponding period of 1883. All the shipbuilding districts, with the exception of Barrow, which has an increase of 6,240 tons on the stocks, have very much less work than they had a year ago. The Belfast figures are down by nearly 48,000, Glasgow by 105,000, Greenock by 55,000, Hartlepool by 21,000, Middlesborough and Stockton by 37,000, Newcastle by 68,00, and Sunderland by no less than 128,000 tons.

Coal and Shipping.—Whatever may be the effect upon the coal output of legislation on the lines of the Miners' Eight Hours Bill the extent to which the shipping trade depends upon the coal producer is very great. Coal may be said to be the staple export for tramp steamers, and the number of such steamers far exceeds the number of regular liners. The Board of Trade figures show that last year 66,000,000 tons of coal was carried to foreign ports from this country. Taking the average cargo at 3,000 tons, this would represent 220,000 cargoes. Eighteen and a half million tons of coal was bought in this country as bunker coal for steamers, and probably as much again abroad at the various coaling stations. It will be seen from these figures how largely the carriage of coal assists the shipowner, and how natural his fear that a Miners' Eight Hours Act may increase the cost of production sufficiently to affect the export trade in coal, more especially, of course, the nearer ports supplied by other steamers.

Iron and Steel.—The trade in iron and steel in the north-west of England is going from bad to worse. The foreign demand has fallen off, and home requirements are greatly reduced by the condition of the shipbuilding trade. There must be a further restriction of output in the absence of inducement to accumulate stocks. Prices are falling, warrant iron being now quoted at 61s. 6d. net cash sellers. Shipments show a marked falling off this year from west coast ports. The total exports have reached 130,662 tons, against 241,895 tons for the corresponding period of last year, a decrease of 111,233 tons. Steel makers are not able to make a profit under present conditions, and it may be expected that at an early date some of the works will close altogether. The latest American reports are uniformly dull, and stocks are said to be accumulating at many furnace plants. The Continental reports, too, point to general slackening of demand. There are rumours, also, of a big strike in the West of Scotland amongst the iron moulders.

CORRESPONDENCE

TONAL METHOD OF NOTATION.

I gather from the review of my book (see *ante* p. 386) that my description has not made it clear that the accidentals are represented by notes other than those shown on the "indicator;" the distinctive marks the reviewer refers to are to show whether the accidental note to which it is placed is the degree below sharpened or the one above flattened. In this respect I maintain that this arrangement makes this notation more suitable for modern music.

In referring to three distinct "striking distances," I presume that he attributes this to the extra length of two of the red upper notes, but as there is only $\frac{1}{4}$ inch difference in length I think he would find that in actual experience (from which I can speak as I have had a piano fitted with this keyboard) that there are practically only two striking distances.

P. Crawford Barlow.

April 2, 1908.

TECHNICAL EDUCATION IN AMERICA.

I should like to be permitted to make a few remarks upon the paper read by Sir William H. Preece, on "Technical Education in America," on the 10th inst., as circumstances prevented me from taking part in the discussion.

In this old country of ours we seem content to muddle along, in old grooves, without co-ordination or design, but I trust and believe that the new Imperial College of Science and Technology, at South Kensington, Birmingham University, and other kindred institutions will, in time, equal, if they do not surpass, any similar university colleges in America or Germany.

The author of the paper and Mr. Charles Moberly Bell gave various reasons which explain the difference in the methods of technical education in America and those at home, with which I entirely agree; but there is one point upon which a difference of opinion may be permissible, and that is the question of how far American progress is due to climate. I lay stress upon this point because, if it were so, it would obviously place other countries at an enormous disadvantage in competition with America, which would be insurmountable.

It seems to me doubtful whether climate has much to do with the question. A very high authority on technical education, at any rate, Dr. Samuel B. Christy, does not hold this view. He observes:—"It has often been claimed that the American temperament is due to our peculiar climatic conditions. As a matter of fact, nearly all the climates of the globe characterise our country, and, in order to disprove this theory, one has only to cross the narrow line that bounds our country either to the North or to the South to find a relief from the strenuosity of the American temperament. The

American temperament is due, not to climatic conditions, but to a mental attitude towards life."

It seems most natural that men who have made their fortunes through education in science, should devote a large part of their wealth to promote technical education; and the result is shown in the liberal endowment in the past of schools, colleges, and universities in America, of which the Carnegie Institute is, no doubt, one of the latest and most notable examples. But it must not be overlooked that private liberality, for the endowment of technical education, is becoming more common in England, as witness the benefactions of the Guilds of the City of London, and to take as an instance my own profession. Miners and metallurgists owe a great deal to public spirited men, like Sir Julius Wernher and the late Mr. Alfred Beit, who have given very large sums to further this object. These are, however, merely a drop in the ocean to what is required in England.

Papers like that presented by Sir William Preece, should turn the thoughts of thinking men to the requirements and present defects of our national educational system, which I trust will be stamped hereafter with the impress of that individuality which forms such a prominent—nay essential—feature of the American type. I sincerely hope that it will be moulded in the best manner possible to satisfy our insular and Imperial necessities; to fit our people for the world struggle; by which alone we can hope to maintain our commercial and political position amongst doubtless friendly, but none the less formidable, rival nations.

A. G. CHARLETON.

353, Mansion House Chambers,
11, Queen Victoria Street, London, E.C.
April 14th, 1908.

May I venture to say a word or two arising out of the able paper read by Sir William H. Preece on the above subject, and the discussion which followed after.

It will be obvious to many of your readers that however much may be spent on technical education, in this country especially, for attaining higher efficiency and skill in mechanical industries and kindred trades, this alone will not help to remove the tariff barriers of protected countries, or relieve the burdens inflicted on British manufacturers by free imports. This is why so many captains of industry do not exert greater efforts or show more enthusiasm in the cause of technical education, or the creation of more industries. What is the good when they are completely shut out of America, Germany, France, and other tariff-protected countries. As the population increases year by year so in proportion will the multitude of the unemployed grow larger and larger, unless some reasonable and practical measure is adopted to decrease the mischief. This is a serious problem for our statesmen to grapple with. Only in one statesman do we see a mind impressed with the seriousness of this business, and this is exemplified in the recent Patent Act.

One of the speakers in the discussion stated:—"For years American manufacturers had been living upon the Old Country as far as skilled labour was concerned, 70 per cent. of the skilled labour being imported."

This remark recalled to my mind a proceeding in connection with our firm, who sent a large and expensive exhibit of patent specialities and other representative goods to the Chicago Exhibition of 1893

The only benefit that we appear to have derived from this exhibit was a diploma and medal, and with the announcement from the officials of this award we also received a communication at the same time, asking us to send on names and addresses of the skilled workmen who had been employed upon our display. This was sent in due course, and the workmen received an illuminated card as a diploma of honourable mention for the part they took in the production and perfection of our exhibit.

This well-advised step is indicative of the way in which our American business men utilise every favourable opportunity for creating a good feeling for themselves amongst skilled workmen of this country. Without doubt this feeling has created a tendency for skilled labour to seek America when lack of work in the Mother Country compels them to do so.

I would like to have said a few words upon the system of apprenticeship which is believed by many manufacturers a very much better system than any practical knowledge that can be had through a Technical College course. A keener supervision and oversight are kept on the lad in the workshops because he is expected in the course of time to leave a profit for his employers.

ISAAC SMITH, M.Inst.E.,
Governor-Director of Sydney Smith and Sons (Nottingham), Ltd.

Basford Brass Works, Nottingham,
April 14th, 1908.

GENERAL NOTES.

PIECE GOODS AT DELHI.—A leading London bank, having large Indian connections, has issued a circular relating to the state of the cotton piece goods market at Delhi, in which the bank says it has never seen such accumulations of stocks as are in Delhi now. The facilities granted have encouraged over-trading, and the bank has noticed that one or two firms, with practically no capital, have received goods to the value of a lakh of rupees. To make matters worse, out station buyers, who usually come in before this, have not yet made an appearance. As far as the bank can see, it is impossible that the existing stocks can be taken up this season, a large surplus will have to be carried over, and with the apparent fall of prices at Manchester, the outlook is described as "very serious."

Journal of the Royal Society of Arts

No. 2,892. VOL. LVI.

FRIDAY, APRIL 24, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

TUESDAY, APRIL 28, 8 p.m. (Applied Art Section.) MISS ISEMONGER, "Lace as a Modern Industry."

WEDNESDAY, APRIL 29, 8 p.m. (Ordinary Meeting.) ALFRED STEAD, Consul-General for Roumania, "Modern Roumania."

THURSDAY, APRIL 30, 4.30 p.m. (Indian Section.) LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay, "Reminiscences of Indian Life."

Further details of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

Tuesday afternoon, April 7; The Right Hon. ALFRED LYTTELTON, K.C., M.P., in the chair.

The CHAIRMAN said that a quarter of a century ago he had the privilege of hearing Professor Seeley's series of lectures which were afterwards embodied in an epoch-making book, "The Expansion of England." No such remarkable book had been published until two or three years ago, when Mr. Richard Jebb's "Studies in Colonial Nationalism" was given to the world. Both books were published by men who looked at the world with their own eyes, and who uttered what they thought in an original and fearless spirit. It was as the author of the latter book, and many other papers read by those who were interested in Colonial matters, that he introduced Mr. Jebb, feeling sure that the paper would be valuable in every sense of the word.

The paper read was—

THE IMPERIAL PROBLEM OF ASIATIC IMMIGRATION.

By RICHARD JEBB.

Recent events in Canada and South Africa have brought into prominence the Imperial problem of Asiatic immigration. The problem arises in two distinct forms, identical in origin but different in political character. The first is a question of internal relations, and the second a question of external relations. The internal difficulty occurs when His Majesty's Asiatic subjects are denied the liberty of unrestricted entry into a self-governing country of the Empire, or when, having been admitted thereto, they are subjected to special disabilities. This condition of affairs raises the whole question of what is meant by Imperial citizenship, a status popularly supposed to connote "equality" in a comprehensive sense. The external difficulty arises when the subjects of a friendly, or even of an allied Asiatic power are subjected to similar disabilities, thus seeming to imperil the continuance of friendly relations. It is quite impossible to deal adequately with every aspect, or even with any principal aspect, of this vast problem, within the limits of an occasion like the present. I will attempt, however, to indicate in the briefest manner how the problem has grown up, and what modifications of our traditional conceptions seem to be required in order that a harmonious solution may be promoted.

CAUSES OF DIVERGENCE.

The divergences of opinion and of policy which have divided the Empire on this question may be traced, I think, to the presence in different combinations of two main factors, which have operated everywhere, in either a positive or a negative form. These two factors may be described as

(*a*) Indigenous nationalism; by which I mean either a conscious intention, or at least an instinctive endeavour, on the part of the

Government and people occupying a territory, to build up an indigenous nation of the European and democratic type.

(*b*) Direct experience of Asiatic immigration, or at least of coloured labour, upon a considerable scale.

Indigenous nationalism is an influence which, in the history of the self-governing Dominions, has tended to become the predominant political force from the time when a generation born in the country, or permanently settled there, has acquired full political control. Historically, therefore, the early nineties, when the grant of responsible government to Western Australia (1890) and Natal (1893) completed the roll of self-governing Colonies, are found to mark a transition in the political evolution of the question.

I.—Before 1890.—The Three Zones.

Taking, first, the half-century before this transitional point, during which the problem first began to develop, the Empire may, I think, be divided into the following three zones of opinion and policy :—

1. The Pacific Zone, embracing countries bordering the Pacific Ocean, namely, the Eastern Australian Colonies, New Zealand, British Columbia, and (incidentally to my subject) the Pacific States of the American Union. Here indigenous nationalism, combined with direct experience, resulted in a demand for stringent restriction of Asiatic immigration, if not complete prohibition.

2. The Indian Zone, embracing countries bordering the Indian Ocean, and including especially the Crown Colonies of Western Australia and Natal. Here direct experience, not being combined with indigenous nationalism, resulted in the sanctioning of Asiatic immigration, unrestricted although regulated.

3. The Atlantic Zone, embracing countries bordering the North Atlantic, namely, the United Kingdom, Eastern Canada, and (incidentally) the New England States. Here indigenous nationalism, not being conditioned by direct experience of Asiatic immigration, resulted in hostility to the idea of restriction, and a desire to restrain that tendency elsewhere.

You will notice that the above geographical division has a maritime instead of a territorial basis. The natural impulse, in considering the Asiatic problem at any given stage of its development, is to ask, What was the sentiment or policy of Canada, Australasia, and South Africa at this time ? But investigation reveals that up to the latter part of the nineteenth century there was no complete consensus of opinion and policy even in Australia, while as regards South Africa and Canada it would be risky to affirm that there is an absolute consensus even now. In each of these three continental groups of States, at least one State is found, in the early period, to have pursued a policy inconsistent with that of its neighbours. The medium of sympathy appears to have been the ocean rather than the land; States which are *vis-à-vis* in maritime position responding to each other's motions, their backs turned upon their rightful, territorial partners. The great stretches of unpeopled territory severing the eastern from the western communities in both Canada and Australia, and the mountain ranges shutting off Natal from the inland Republics, seem to have repelled instead of transmitting the waves of national sympathy. But, as everyone admits nowadays, it is Imperially desirable that these continental federations, actual or potential, should each be welded into a homogeneous unit. It is satisfactory, therefore, to find in the period subsequent to the early nineties, the maritime zones beginning to dissolve into the more natural, territorial unities; and on the part of these unities a growing tendency towards agreement in opinion and policy, not only internally as regards their component provinces, but also externally, in their Imperial association.

The Appendix.

Space forbids an attempt to trace in detail the growth of the opinion and policy which I have ascribed to the three zones respectively. But as an aid to those who may wish to check my generalisations or go more thoroughly into the history of the subject, I have had prepared and appended a condensed summary of the Colonial laws, past and present, relating to Asiatic immigration, and of British and American treaties with China and Japan. In addition there is a population Table intended to show the relative proportion of Asiatics to Europeans in the various Colonies at successive periods, and to distinguish the different classes of Asiatics. But two reasons must be mentioned for using this Table with caution. To begin with, owing to the defective organisation of the Empire, it is impossible to prepare an accurate statistical statement of this kind, the bases of the returns being different in almost every part. Secondly, the social effect of the Asiatic ele-

ment upon the life of a country is not indicated by the proportion of Asiatics to Europeans taken over the whole area. In practice the Asiatics, and especially the Chinese, are apt to congregate together. The districts thus affected feel the influence severely, and become sensitive spots in the national organisation, indirectly affecting the social health of the remoter parts and of the body politic as a whole. Thus, for example, though the percentage for the Dominion of Canada may be trifling, the density in the neighbourhood of the Pacific coast may seriously affect the welfare of the nation.

The Pacific Zone.

In the Pacific Zone the restriction movement began in the late fifties, when the discovery of gold in Victoria and New South Wales induced an influx of Chinamen to the country which steam had now brought within easy reach. The first (1855) law passed by Victoria, remained the type of all the subsequent Colonial legislation up to 1897—the year of a Colonial Conference—and this type still survives in the statute-books of Canada and New Zealand. Its constant features are that it is discriminatory in character—specifying Chinese—and effects restriction by limiting the number of Chinese immigrants in proportion to the tonnage of the ship bringing them and by imposing a landing charge of £10 or more. In the sixties and seventies there was a relaxation of the restriction policy, amounting generally to total cessation. But the eighties witnessed a strong revival, and since then there has been no sign of reaction. The climax came in 1888, when the arrival at Melbourne and Sydney of vessels bringing unusually large parties of Chinese immigrants led to such an outburst of popular feeling that the Government of Victoria felt obliged to strain the law, while at Sydney the Premier, Sir Henry Parkes, deliberately violated it rather than allow even the authorised number of immigrants to land. Subsequently a Conference was held at Sydney, as a result of which all the Australian colonies and New Zealand enacted stringent laws of a fairly uniform character.

British Columbia, meanwhile, had been doing her best to emulate the policy of her antipodean sisters. But as a province of the Dominion her power (see App.) to legislate about immigration was subordinate to that of the federal Parliament, *i.e.*, to the opinion and policy of the Atlantic Zone, and her attempt (1884) to exclude Chinese was vetoed at Ottawa. She then reverted to the much less defensible policy of trying to deter Asiatic immigrants—as the Transvaal Republic did in the similar situation arising from its Conventions with Great Britain—by imposing special disabilities upon those already resident in the country. Chinese had been forbidden to acquire Crown lands, and they were now further penalised by a poll-tax and by a differential charge—as in Queensland—for a miner's certificate. By way of discouraging this movement the federal Parliament then (1885) passed a mild restrictive law on the Australian model, with which British Columbia had to be satisfied during the remainder of the period. In the meantime the immigration of Chinese labourers was totally "suspended" by the United States, which had persuaded China to admit the propriety in certain circumstances, to be judged by the American authorities, of this extreme step being taken. It is worth noting that in the eighties, as at the present time, the British States in the Pacific Zone were asking why the British Empire should not obtain by treaty with the Oriental Powers the same recognition as the United States of the right to restrict or "suspend," if not to prohibit, immigration.

The motive of this policy has now to be stated. In the Pacific Zone coloured immigration of any kind, but Asiatic immigration in particular, is held to be incompatible with the intention of building up an indigenous democracy of the British type.

The ultimate and decisive ground of objection, invariably recognised as such in the reasoned statements of Pacific representatives, is either that the white and coloured races are unable to fuse, or, if there is a fusion, that they produce a racial and social type inferior to the Anglo-Saxon. The only considerable and persistent exception to this belief seems to be furnished by the case of the warrior Maories in New Zealand, where the limited fusion already accomplished has not, as in South Africa, come to be visited with marked social disapproval. But as regards the immigrant coloured races, the mature belief of the Pacific Zone is that none of them can offer a blend which would not deteriorate the European race.

If, however, there is to be no fusion, the ultimate result of coloured immigration, consisting as it does of low-grade labourers, can only be to create a "helot" class, for which

no place can be found in a pure democracy. Since in the Pacific Zone Nature has imposed no inherent obstacle to the development of a pure democracy, the opinion is that it would be criminal folly to create deliberately a difficulty like that of the American negro problem.

Accepting the foregoing argument, the case against allowing coloured immigration upon a large scale seems to be unanswerable, except by denying the right of indigenous nationalism, which no one ventures to do nowadays. It is sometimes urged, however, that moderate immigration of coloured labourers or house servants may be desirable in the early days of virgin territory ear-marked for British democracy, in order to mitigate the domestic discomfort of the wealthier settlers, or to accelerate the development of material resources, and thus to expand the economic opportunity for European settlement. But in the Pacific Zone this line of reasoning, formerly not infrequent, finds only a constantly diminishing support. It is, in reality, an attempt to reconcile two conflicting ideals, viz., the rapid acquisition of material wealth, or the avoidance of domestic drudgery, and the building up of a pure democracy. In practice, one of these ideals must be sacrificed to the other. The creation of a "helot" class cannot be justified by pleading that it would only be a small one. If coloured labour in any district becomes a permanent institution — as it necessarily has throughout South Africa—the effect always is to stigmatise the work in which it is employed. It thus destroys the foundation of a democratic industrial system, which is incompatible with the habit of regarding manual or domestic labour as undignified.

If, on the other hand, coloured labour is introduced with the intention of dismissing it later on, the immediate effect is—as I think the experience of British Columbia has shown—to deter the immigration of the white labour which is required to replace it. The employer bases his plea for the temporary expedient on the ground that white labour is not forthcoming, that it is not reliable, or is extravagantly dear. But what is the inducement, in British Columbia, for example, to European immigration of the working class, except the abnormally high rate of wages, and the supposed opportunity to jump at any chance of betterment which may present itself? If, with this inducement, there is no adequate inflow of white labour, there is hardly likely to be more when the competition of Asiatics either destroys, or seems likely to destroy, the attractions of the new land. The employers' desire to have labour "on tap," like water or electricity, may be natural enough, but cannot be satisfied through an Asiatic conduit, without aggravating the very difficulty which that expedient was intended to overcome. The conclusion is, from the standpoint of indigenous nationalism either that development must be allowed to proceed at a slower pace, and with greater domestic hardship, or else that some system must be organised for supplying the labour needs of the newer territories from the Imperial reservoir of white workers, who must be trained to the task.

So far the argument of the Pacific Zone has applied against coloured immigation generally. But the objections are amplified against Asiatic immigration owing to certain characteristics which are common to the Chinese, Japanese, and people of India, although most pronounced in the case of the two former. Unlike the savages, more or less primitive, of the South Sea Islands or the North American and Australian continents, these Asiatic races are heirs of a highly-developed civilisation alien in all its characteristics from our own. Socially the result is that the Asiatics are not easier, but more difficult than the primitive races to assimilate—if assimilation were desirable—and when present in large congregations, as in San Francisco, they are apt to set up their own community complete with social, economic, and even judicial machinery, a kind of *imperium in imperio* threatening the supremacy of the State. Economically, again, the ancient civilisation of the Asiatics has endowed its children with aptitudes far above the sphere of unskilled labour, for which purpose alone the British coloniser ever feels an actual need of their assistance. Their marvellous skill in all the arts of trade, and their ingenuity in various branches of handicraft, notably woodworking, enables them, with their lower standard of living, to oust the white settler from his monopoly of these important economic opportunities.

Such, then, is the opinion and policy of the Pacific Zone, which seems to be becoming more decided and determined as time goes on. Subject to an essential modification, it has already captured the Indian Zone, and bids fair to convert the Atlantic Zone before long. But, before passing on, let me enter a protest against the still popular fallacy that the Pacific attitude is dictated merely by the selfish insistence of well-organised and rapacious

Labour. Two circumstances tell decisively against this view. One is that responsible local representatives, not dependent upon labour suffrages, invariably argue for restriction or exclusion on the higher social and political grounds in relation to which the labour question is subsidiary, although essential. In support of this statement I must be content with referring you to the 1888 Blue-book (C. 5448) or to the report of the Canadian Royal Commission in 1902 (Dominion Sessional Paper, No. 54, of 1902). The second evidence is the modern adherence to the restriction movement of nearly all Australasians and an increasing number of Canadians, who are not "in politics," and whose material interests in many cases are opposed to the extravagant demands of Labour. Their insight contrasts favourably, I think, with that perverse body of opinion, to be found in all countries, which instinctively opposes some policy of enormous national importance lest the immediate advantage should accrue to persons not thought to deserve the benefit.

One further point. No one here will desire to excuse or condone the iniquity of the mob violence to which the Japanese were subjected a few months ago in Vancouver. But lest abstinence from such excesses should be thought to signify an apathetic attitude, let me remind you of the language used in 1888 by that respected statesman, Sir Henry Parkes, whose every instinct was against lawlessness and tyranny. Defending his refusal to let the Chinese land, he said, in the local Parliament:—"If in doing that we have infringed any law, I say that this House is bound in honour to indemnify us, because, in infringing the law, we have obeyed the higher law of conserving society. . . . Neither for Her Majesty's ships of war, nor for Her Majesty's representative on the spot, nor for the Secretary of State for the Colonies, do we intend to turn aside from our purpose, which is to terminate the landing of Chinese on these shores for ever, except under the restrictions imposed by the Bill, which will amount, and which are intended to amount, to practical prohibition." The tone of defiance, uncalled for by the action or inaction of the Imperial authorities, must be attributed, of course, to the excitement of the moment. But this statesman, who was knighted for his services to the Empire, was giving utterance to a national resolve which, if occasion ever arose, would, on referendum, be quietly confirmed throughout the Pacific Zone. The enthusiasm of the invitation lately sent by the Commonwealth to the American Fleet springs from the consciousness that the Australian national policy no longer lacks a powerful sympathiser.

The Indian Zone.

In the Indian Zone, meanwhile, opinion and policy were developing under very different influences. Here the centres of interest are the *vis-à-vis* colonies of Natal and Western Australia, both of them in charge of a Colonial Office which, with so many coloured races committed to its care, could not be expected to be guided in its policy by indigenous nationalism. Equal opportunity for all, and special protection for the weaker races was the unimaginative, but not unworthy, principle of Crown administration.

When, in 1856, Natal was constituted a separate Colony, the Government at once inaugurated the system of importing Indian labourers, and encouraging them to settle in the country after two or three years of contract service. Thus early began a continuous process, of which the disastrous consequences are only now beginning to be appreciated fully. We can hardly, however, blame the Crown officials for having completely failed to anticipate the rise of the indigenous nationalism which now impels South African Governments to safeguard jealously the white man's economic opportunities. Throughout this period native-born South Africans of our race endeavoured, as a rule, to suppress their instinct of indigenous nationalism lest, yielding to it, they might appear to side with the Boers against the British Crown and British ideals.

Moreover, it must not be forgotten that the conception of an indigenous European nation in South Africa can never be so thoroughly democratic as in countries, like those of the Pacific Zone, which are free from the complication of a huge native population. In South Africa the horizontal colour line has always been, and seems likely to remain, a fundamental fact. The Boers who, throughout this period, were working for the national ideal of their own race, were evolving a primitive type of democracy superimposed upon a caste of coloured labour, which they excluded from political rights. Even from their standpoint, therefore, the importation of Asiatics was not fatally objectionable, if in effect it only supplemented the existing labour caste. Indeed, a generation ago, we find the Dutch farmers of the Cape Peninsula clamouring for Chinese labour. The resistance of South

African nationalism to Asiatic immigration only became vehement as the economic and social differences between the primitive native and the highly civilised Asiatic began to be realised through direct experience.

Finally, at this time there was nothing like the existing native population available for labour in Natal. Most of the present population has come in under the security of British rule. The Zulus, who have never taken kindly to labour, were still engaged in congenial warfare under the chieftains who were soon to give us so much anxiety. The planters on the humid coast lands were crying out for labour which could be depended upon to sow and reap when required, instead of being here to-day and gone to-morrow. All things considered, it was not likely that immediate relief from a pressing economic difficulty would be rejected on the ground that it might eventually prejudice the development of a South African nation. So the importation of Indian coolies began, subsidised out of public funds, regulated in the interests of the immigrants, but not otherwise restricted, and continued without serious check up to the grant of responsible government in 1893.

Across the Indian Ocean, an Administration imbued with the same Imperial tradition was guiding the destinies of Western Australia. Far removed from the influence of Sydney and Melbourne, where the long struggle to terminate "transportation" had given consciousness to the instinct of indigenous nationalism, the pioneer settlers of Western Australia actually asked, in the fifties, that they might be blest with the convict labour which the Easterners had rejected. Deprived of this resource in 1868, their considerate rulers gave them a law (1874) to regulate the importation of coloured labour. "In 1881," writes Mr. Gillies, the Premier of Victoria, "the Colonies again took alarm from the action of Western Australia, where measures were being taken to import Chinese labourers" (C. 5448, p. 25). In 1882, and again in 1884, Acts were in fact passed, providing for the registration and indenture, but also the repatriation of African and Asiatic labourers thereafter imported—thus precisely anticipating the main features of a much-discussed ordinance of a more recent date. Mr. Gladstone's Government, it may be noted, assented to these Acts, although the second and more stringent was held up for some months.

But after the middle of the eighties the instinct of the native-born began to exert an irresistible pressure on the Government of Western Australia; mainly, perhaps, because the discovery of the Koolgardie goldfields was now beginning to attract an increasing inflow of Australian "t'othersiders." In 1886 a Chinese restriction Act on the Eastern model was adopted. A representative of the Crown Administration attended the Sydney Conference of 1888, though he did not vote; and in 1889 another Chinese Immigrants Act was enacted, exempting labourers brought in under contract. These Acts led up to the policy of the responsible Government, one of whose earliest measures was to exclude Chinese from among the labourers allowed to be imported under the Act of 1884. Henceforth Western Australia belongs definitely to the Pacific Zone, of which the new Commonwealth (1900) presently assumed the leadership.

The Atlantic Zone.

In the Atlantic Zone opinion and policy were being governed by the fact that here there was no such thing as Asiatic immigration, either spontaneous or induced. The question was, therefore, of indirect interest only. Without direct experience — that frequent enemy of cherished theory—British sentiment instinctively opposes the principle of restriction, which seems to conflict alike with the religious conception of brotherhood, the democratic conception of equality, and the Imperial conception of uniform citizenship. Under these influences the tendency was, unfortunately, to impute ignoble motives to the Pacific policy, losing sight of the larger issue in a haze of prejudice against the extreme protectionism of the labour unions.

This instinctive dislike of the restriction movement was reinforced by special considerations in both England and Eastern Canada. As the trustees of so vast an Asiatic population English governments naturally clung to the idea of Imperial equality. Assenting with the reluctance of conscious helplessness to the restrictive laws of the Pacific Zone, they exerted their moral influence to urge, not merely the claims of Imperial citizenship, but also the diplomatic principle that "exceptional legislation calculated to exclude from any part of Her Majesty's dominions the subjects of a State at peace with Her Majesty is highly objectionable." (March 1877. Dispatch to Governor Cairns, Queensland.) Twenty years later, as we shall see, this principle was to find at the Colonial Office a powerful but enlightened advocate.

In Canada likewise there were special considerations which I can only enumerate briefly. First, there was the insistent need of labour to fertilise the Montreal investments in British Columbia, and the precedent of importing Chinese which had been afforded by the Canadian Pacific Railway in the course of its construction. Second, the feeling that in such matters the example of the United States presumptively is bad, the Americans having "suspended" the immigration of Chinese labourers. Third, the reluctance of a Federation to be "bossed" by a single, remote, and junior Province. Hence the Dominion Government, ruled by the Eastern provinces, entered and pursued the path of Chinese restriction with manifest reluctance, enacting only the minimum required to keep British Columbia from violent agitation. In the period under review no advance was made on the original Chinese Immigration Acts of 1885 and 1886.

II.—After 1890.

We now come to the modern period in the development of this Imperial problem. Like Western Australia, the Colony of Natal, after receiving responsible government, begins to betray the impulse of indigenous nationalism. Almost her first Act forbade the subsidising of Indian labour importation—implying that this system was no longer regarded as a public benefit. In 1895, an attempt was made to enact that Indian coolies should be repatriated on the expiry of their indentures, but the Imperial Government intervened. As an alternative, therefore, to repatriation, the coolies were made liable to an annual payment of £3, which has come to be regarded as a license entitling them to reside. In the previous year an Act had been passed disqualifying for the franchise Asiatics as such, save those already on the register. But the correspondence anent these measures stimulated the Natal Government to try whether their object might not be attained consistently with the Imperial objection to legislation of a "special" character. Examples of ingenious experiment in "general" legislation were the Franchise Law of 1896, disqualifying all persons coming from countries not possessing elective institutions; and a law refusing trading licences to those who did not keep their books in English. But of much wider importance was the celebrated Immigration Restriction Law of 1897, which was soon to make the "Natal Act" a household word throughout the self-governing Colonies. True to the "general" principle, this Act included in the "prohibited immigrant" category, "any person who, when asked to do so by an officer, shall fail to write out and sign, in the characters of any language of Europe, an application to the Colonial Secretary in the form set out in the Schedule." This law was intended to restrict the immigration of free Indians, not under contract to labour, many of whom were already traders.

The Colonial Conference, 1897.

The Colonial Conference of 1897, held soon after the Natal Act had reached Downing-street, is a most important event in the history of our subject, because it occasioned the first effort to systematise the practice of the Empire. Its significance appears to have been entirely overlooked by those who complain that the Colonies have not shown a sufficient sense of Imperial responsibility, and who suggest the holding of a Conference to explain the matter to them. In my judgment the failure to appreciate the real inwardness of the question, and to modify opinion or policy in accordance therewith, has been much more marked on the part of the Government of India, and of the complainants alluded to, than on the part of the majority of the self-governing Colonies. The truth seems to be that the whole question was thoroughly thrashed out in 1897, that an important movement towards uniformity ensued, and that the subject was not reopened at the Colonial Conferences of 1902 and 1907, simply because no one had any fresh proposal to offer. Though the 1897 report has never been issued, the published summary is enough to show that Mr. Chamberlain was thoroughly in sympathy with the Colonial point of view, and was anxious only that "general" laws should be preferred to "special" or discriminatory legislation, as the means of restricting Asiatic immigration. He, therefore, commended the principle of the new Natal Act.

Results of 1897 Conference.

Australasia.—In the southern half of the Pacific Zone the Natal Act soon was adopted by several of the colonies, including New Zealand. When the Commonwealth arrived it proceeded to frame a similar measure for all Australia. Presently the form of the education test was modified and the discretion of the immigration officer was enlarged, so as to make the Act serve the purpose of prohibition rather than restriction. Australian sentiment was, however, too

English not to feel some antipathy to the plan of excluding people by means of a subterfuge, instead of specifying them outright as prohibited immigrants, and so the Act was a distinct concession to the Empire. New Zealand, indeed, seems inclined to relapse to the former method of "special" legislation, having quite recently grafted a formidable "education test" — involving ability to read English — not on her general Immigration Restriction law, but on her original anti-Chinese Act of 1881. This Bill has, I believe, yet to receive the Royal assent. It may here be noted, as another new departure, that Sir Joseph Ward has lately proposed to subject the industry of market gardening, which is largely in the hands of Chinese, to the competition of prison labour.

South Africa.—In South Africa, one of the last laws enacted by the Orange Free State—which had in 1890 practically prohibited the settlement of Asiatics—was a measure (1899) embodying the principle of the Natal Act. Cape Colony followed suit in 1902, and Southern Rhodesia in 1903. After the war, immigration into the new Colonies was controlled by the Governor under the Peace Preservation Ordinance, which was administered in harmony with the principle of the Natal Act. A novel characteristic of this Crown administration was that it soon caught the spirit of indigenous nationalism. Witness its policy for meeting the labour shortage on the goldfields. Baffled, as Natal had been, in the attempt to obtain Indian labour subject to repatriation—the Government of India requiring that registration should be abolished—it preferred to see the wages of a huge industry lost to the Empire rather than imperil the future of the South African nation by allowing another swarm of Asiatics to spread over the land. The South African opposition to the Chinese—so far as it was non-factitious—arose partly from a fear, soon justified, that it would be impossible to prevent "leakage" from the compounds, and partly from a doubt, illuminated by recent references to Madagascar, whether even in those "booming" days there was not a sufficient supply of native labour for all immediate requirements. To meet the risk of leakage, Cape Colony then passed a law prohibiting the entry of Chinese, other than British subjects, and ordering a registration of those already resident.

The mention of registration brings me to the recent crisis in the agitation of the Transvaal Indians. It needs but little reflection, and still less experience, to understand that a State which has frontiers must register the resident Asiatics if it intends effectively to exclude the influx from a neighbouring territory where Asiatics are numerous. The whole history of the subject shows the Asiatic to be an adept at personation. In the early days Victoria was driven to registration by circumstances similar to those of the Transvaal, and in America the long Canadian frontier has been a constant source of difficulty to the United States in enforcing their restrictive policy. One obvious lesson is that it is highly desirable for contiguous States to have a uniform immigration policy. But even assuming Federation in South Africa it is doubtful, to say the least, whether the other Provinces would allow the mass of Natal Indians, male and female (see population table), to spread themselves over the whole sub-continent. Unfortunately Natal, having based her economic development on Indian labour for fifty years, has found it difficult to change her ways. Under stress of the labour shortage after the war, she reverted to the plan of subsidising the importation of contract labourers from India, reluctantly allowing them to settle in the country afterwards, the Indian Government still being unwilling to sanction terms of repatriation except on prohibitive conditions. The result is that in Natal the Indian population now greatly exceeds the European, which has begun to decline to an alarming extent. Last year she gave the Transvaal permission, previously withheld, to recruit natives for the Rand, thus increasing her own dependence upon imported Indians for carrying on her plantations, farms, collieries, and public works. In the name of South Africa, Mr. Smuts has publicly called upon her to desist (January 27th). In response, perhaps, her Government appear (Reuter, March 27th) to have announced their intention of legislating to place a time-limit on Indian immigration and Indian trading licences, giving compensation for the loss of the latter. But, considering the financial stringency which all the South African governments are experiencing, and also the unsolved difficulty of the labour shortage, the likelihood of this policy being carried out seems somewhat remote. Meanwhile the passage of a Natal Act in the Transvaal last year has made the principle of this measure common to all South Africa.

Canada.—Unlike Australia, New Zealand, and the South African Colonies, the

great Dominion in the Atlantic Zone was not prepared to adopt the Natal Act, which would have represented a general extension to all Asiatic races of the restrictive policy hitherto applied to the Chinese only. A definite decision was called for in 1898, when British Columbia passed a law prohibiting the employment of Japanese and Chinese on certain works. In connection with the federal disallowance of this Bill, Mr. Chamberlain urged (July 20, 1898) upon the Canadian Government "the importance, if there is any real prospect of a large influx of Japanese labourers into Canada, of dealing with it by legislation of the Dominion Parliament on the lines of the accompanying Natal Act, which is likely to be generally adopted in Australia." (Sessional Paper 54 of 1902, p. 398).

Instead of legislating, however, the Dominion Government appointed a Royal Commission to investigate the situation in British Columbia. The Commission found that after a period of diminished immigration the Chinese had again begun to arrive in large numbers, and that the Japanese — more dangerous competitors because more versatile —had also entered upon the scene, no less than 10,000 having arrived in the twelve months beginning July 1st, 1899. A most interesting account is given in this report not only of conditions in the United States, but also of the elaborate emigration system, fully controlled by the Government, which exists in Japan. The origin of the influx was said to be that an outbreak of bubonic plague at Honolulu, followed by quarantine, had caused the Japanese emigrants destined for that port to be diverted to the American coast.

The Commission recommended drastic restriction of both Chinese and Japanese immigration. In the case of the Japanese there appears to be a difficulty in effecting restriction by confining certain material privileges to British subjects, because the Japanese seem able to take out certificates of naturalisation, if permitted, without renouncing their allegiance to Japan. You may have noticed the recent report of comments passed by Judge Grant in British Columbia. But this is a digression. The Japanese Government, anticipating the tendency of the Commission, forestalled the demand for restrictive legislation by issuing instructions (August 2nd, 1900) to the Governors of Prefectures that they were to prohibit for the time being the emigration of Japanese labourers to Canada. At once the immigration practically ceased, and the Commission concluded that "nothing further is needed to settle this most difficult question upon a firm basis than some assurance that the action already taken by the Government of Japan will not be revoked."

Whether or not the Canadian Government succeeded in obtaining any real assurance, they contented themselves with raising the existing landing tax on Chinese immigrants to £20, and afterwards to £100, which for the time being had the effect of stopping Chinese immigration. But when the resident Chinese found themselves able to demand monopoly wages, arrangements were soon made by Chinese organisations for the Canadian employers, in effect, to pay the increase in the landing tax. The present position seems to be that Chinese immigration is again reviving.

The Anglo-Japanese Treaty.

One reason for the reluctance of the Canadian Government to legislate against the Japanese was that they were now contemplating adhesion to the Anglo-Japanese Commercial Teaty of 1894, with a view to developing trade with the Orient. This treaty guarantees reciprocally "full liberty to enter, travel, and reside," and the self-governing Colonies were expressly excluded from its scope. Our Government offered, however, to negotiate a special immigration clause for any colony which might desire to adhere. But Canada, apprehending apparently that the bargain might have to be paid for in commercial disadvantage, preferred to accept the treaty as it stood, and adopted it (1906) by an Act of Parliament, which has lately proved effective in placing *ultra vires* the renewed attempt of British Columbia to enforce a Natal Act of her own.

The only Colony which adhered to the Treaty, subject to an immigration clause, was Queensland, particulars of whose arrangement, resembling that of the United States, will be found in the Appendix. In this instance, the concession does not seem to have involved any sacrifice of commercial privilege. Moreover, Japan gave a definite assurance (Tokio, March 16, 1897) that she would be prepared to admit any of the scheduled Colonies or Possessions to the advantages of the Treaty on the same terms as Queensland. But the Commonwealth, which has taken over Queensland's external obligations and controls immigration, has failed in an attempt to acquire

the same privileges. (Question in Senate, Nov. 13th, 1907.) Mr. Deakin, however, according to a Press interview, does not set a high value upon the most-favoured-nation privileges, and so far Canadian experience hardly seems to justify the idea that a big trade may soon be worked up with Japan. A more important point is that there has been some dispute as to the scope of the safeguarding clause, Japan contending that Queensland ought to admit a sufficient number of Japanese to keep up their former numbers. It appears, also, that many of the alleged non-labouring Japanese coming to Queensland with proper passports turned out, as in the United States, to be labourers after all. Studying the correspondence in connection with Australia, I find it impossible to retain the theory that all Japan wants is a formal recognition of her national equality. While nominally conceding our right to control immigration—which is indisputable in international law—and denying that she desires to force her subjects upon the Dominions, Japan, nevertheless, makes claims which if admitted would nullify the system of restriction. Besides the instance above mentioned, she took exception to the Australian "education test," on the ground that by specifying a language of Europe it stigmatised the language of Japan. The Dominions had gone out of their way to substitute the test of language for that of race. Yet an attempt is made to drive them from the ground to which they had courteously receded in the belief that it would not be challenged. Australia, thus pressed, has eliminated the specification of a particular language, leaving the matter to the discretion of the officer. On the British side an offer has, I think, been made to settle the question on a basis of absolute reciprocity, Japan applying to British labourers precisely the same restrictions or prohibitions which the Dominions apply to hers. If this offer has been rejected, evidently the motive is something more than a natural desire for national equality. The privilege of emigration to the Dominions is of great pecuniary value to the labourers themselves, to the Japanese shipping companies, to the emigration companies, in which prominent citizens are said to be interested, and to the Government which draws revenue from the earnings of emigrants never allowed to repudiate their allegiance. In the Queensland correspondence (1900) the Japanese authorities mention the "distressed state" of the emigration companies as a reason for objecting to the Queensland restrictions; and in the Commonwealth correspondence (1901) they describe the Immigration Act as a "severe blow" to the Japanese shipping companies. From this standpoint, no doubt emigration to Korea is no substitute for emigration to Australia or British Columbia.

The Canadian Treaty with Japan had not long been arranged before the influx of Japanese began to revive on an alarming scale, leading to the outbreak of mob violence in Vancouver last year. The matter has been investigated by the Deputy Minister for Labour, Mr. Mackenzie King, who has explained it in an instructive report. It seems that a fierce struggle had been going on in the Hawaian Islands—long a favourite outlet for the Japanese—between the Planters' Association, which wished to reduce wages by multiplying labourers, and the Japanese unions which wished to raise wages by restricting the numbers. When the Japanese leaders began to ship their surplus countrymen over to San Francisco, the planters formed an alliance with the Pacific Coast exclusion leagues, which they are said to have subsidised, and together they succeeded in getting the Washington Government to prevent the migration of Japanese labourers from the Islands to the mainland. Checkmated in this direction, the Japanese leaders then diverted the stream to British Columbian ports. But this did not account for the whole of the influx. It has come to light that a Japanese trust had been cleverly organised in Vancouver for supplying Canadian corporations with Japanese labourers, in collusion with the emigration companies of Japan, and had already obtained one or two important contracts. Hence the special mission of a Canadian Minister to Tokio, where he succeeded in obtaining the written assurance quoted in the Appendix. It has, however, been stated at Ottawa that the Japanese Government further undertakes not to let emigrants go to Canada except under contracts approved by the Dominion Government. Ten years ago Queensland made a similar arrangement with Japan but it did not work without considerable friction.

By way of checking the indirect Japanese immigration, the Canadian Government then issued a "general" regulation forbidding the admission of any immigrant not coming direct from his own country. But almost the first application of this rule was to a large party of British Indians, transhipped at Hong-kong. In

hopes of adjusting this new branch of the difficulty by Imperial co-operation, the Canadian Government have sent Mr. Mackenzie King to confer with our Government, and I am sure we all wish him every success in his mission. In an official communication lately published (March 28th) Canada explains that her purpose is "to provide for the control of immigration by reciprocal action between the country of citizenship and the country of destination."

In brief, the impression I have derived from watching recent developments, is that Ottawa has now come round to the standpoint of the Pacific Zone, not driven by British Columbia, but induced by the gradual conversion of Eastern opinion through fuller understanding of the facts. But had this conversion taken place ten years ago, the Dominion might then, by adopting the Natal Act, have averted all the recent complications, as they have been averted in Australia.

Conclusions.—Imperial Citizenship.

Returning now to the propositions with which this paper started, the nature of Imperial citizenship must be deduced from the purpose for which the Empire is thought to exist. That purpose, I submit, is the promotion and protection of Nation-States. By Nation-States I do not mean States founded upon some petty tribal distinction or accidental boundary, but States founded on the principle that combination into one national body is necessary and advantageous to small kindred communities which occupy contiguous or adjacent territories. This theory of the Empire seems to be supported by the following evidence:—

(1.) The modern Constitution of the Empire; the Imperial Conference having affirmed by its own resolutions and proceedings that the Empire is not a political amalgamation but an association of separate, self-governing Nation-States, some of which are responsible for the government of Dependencies.

(2.) The fiscal systems of the Empire, including our own, which testify that the separate national interests take precedence of the common Imperial interest.

(3.) The recent acquiescence by our present Government in the restrictive policy of the Transvaal, indicating a conversion to the above Imperial theory of that body of English opinion which formerly was most hostile to it, at least in so far as the question of Asiatic immigration was involved.

Assuming this theory of the Imperial purpose, it follows that Imperial citizenship cannot confer any rights inconsistent with it, *e.g.*, the right of any citizen to settle in any State where his presence would be injurious to its national civilisation. Obviously the mere fact of the British flag does not alter the social or economic consequences of Asiatic immigration, and, therefore, even the claim of resident Asiatics to equal treatment can only be admitted when their numbers are so small that their influence is negligible. Studying the course of legislation you will find that British subjects have been exempted from restrictions only in cases where the main danger was confined to the influx of foreign Asiatics. In the Pacific Zone, the Asiatics are, or may become, a diminishing and negligible quantity, because their failure to bring their womenkind precludes a natural increase, while the immigration laws ought to prevent fresh arrivals. In South Africa, on the other hand, the Indian female population is already so large that the prohibition of further immigration would not tend to any reduction of the excessive Indian element. Extensive repatriation, therefore, must precede the removal of their present disabilities. If this could be effected, without compulsion or other hardship, only by offering a lavish pecuniary inducement, may not the Imperial object be worth the sacrifice on the part of the United Kingdom, which was originally responsible for the mistaken policy of the last fifty years?

It has been suggested that by way of compensation for their exclusion from South Africa the Indians should have East Africa set apart for them. There is no objection to this proposal in Imperial theory, unless the local natives have a case. The handful of white settlers already there are not an indigenous people, nor is it clear that they are likely to be the progenitors of such. In any case, the Imperial territories already reserved for our race in North America, Australasia, and elsewhere are large enough, in all conscience, without ear-marking any more. Perhaps, however, the Indians would not really value the opportunity to colonise a country for themselves—pioneering on a rice-diet scale of remuneration and profit. The Asiatics are not pioneers: throughout the ages they never occupied neighbouring Australia for themselves. The attraction to them of the self-governing Dominions is the high scale of profit established by the predominance of the white settler; they seek to reap where he has sown. Nevertheless, if the reservation of East Africa

for Indian settlement would assist, either morally or materially, the solution of this problem, by all means let us agree to it.

To my mind a more practical recognition of their Imperial rights would be to satisfy their desire—expressed by the National Congress—for a fiscal system like that of the self-governing Dominions, devised to develop their own industries, and to make India a self-conscious economic unit. This would not only tend to diminish the economic need for emigration, but would show that the Imperial purpose of promoting and protecting Nation-States is not formulated for the exclusive benefit of the European race.

Having thus brought India within the scope of the Imperial purpose, we might without hesitation instruct her Government to prevent emigration of the labouring and trading classes to the self-governing Dominions. According to the newspapers, the Governor-General of Canada has already urged this matter on the attention of the Viceroy. As for the requisite machinery, the law mentioned in the Appendix shows that in India paternal control is already exercised on a considerable scale, though not to the same extent as in Japan.

Foreign Relations.

It remains only to discuss the ultimate bearing of the position here developed upon the question of foreign relations. The first point to appreciate is that indigenous nationalism, or the development of national ideals, enjoys no divine right, but depends in the last resort upon the power of self-defence. States not under the same flag are under no obligation to make sacrifices for each other's national ideals. But the Nation-States allied under the British flag are morally, if not constitutionally, bound to support any one of their own number, or of their Dependencies, whose national interests are threatened by a foreign Power, without reference to the interests of that Power. From this standpoint it was not inconsistent—though it may have been unwise—for the Empire to demand more for the British Indians from the Transvaal Republic than would be compatible, after annexation, with the national intention of British South Africa.

To take another example, it is difficult to see how the Asiatic Powers can be expected to admit the right of the Australians to reserve from Asiatic settlement the vast northern territory which they have not succeeded in peopling themselves, and which is climatically more attractive to Asiatics. But the Commonwealth, realising the international weakness of its position, has now plainly resolved to provide the necessary sanction of its white Australia policy by so developing its power of self-defence that its alliance would be valuable to other Powers actuated by a similar national ideal.

Assuming the duty of the Empire to protect the Nation-States up to the limit of its capacity for resistance, is there any better way of restricting Asiatic immigration than that of the Natal Act? This system has the merit not only of universal application, but also of elasticity. By varying the nature of the "education test," and the amount of discretion given to the officer, the Natal principle may be worked so as to restrict either prohibitively or in moderation. A study of the Appendix will provide illustrations of this elasticity. It is easy to insert clauses exempting the better class of students, travellers, &c. The objection to the Act that it is "slim" instead of straightforward, appeals forcibly to many of us, but is an objection, after all, to the recognised methods of international diplomacy. If the peace of the world, or even international politeness, requires that in public we should "save the face" of our friends, surely we can make this sacrifice of our simpler instincts. In order to attain Imperial uniformity on this basis, legislation of the Natal type would have to be enacted not only by Canada but also by the United Kingdom, where the principle of regulating alien immigration has, it may be noted, already been admitted to the Statute-book.

If complete restriction can really be arranged by mutual consent, again so much the better. But prudence suggests, and the Canadian experience has shown, that even if restriction can be effected by consent, it is unwise for any nation to surrender its sovereign right of controlling immigration. The United States, for example, seek to arrange restriction by diplomatic methods; but, as the Appendix shows, they have never bartered away the sovereign right of enacting, and trying to enforce restrictive immigration laws. In theory, absolute reciprocity of treatment ought to satisfy both parties. But the difficulty is that in practice the Asiatic Powers do not desire to restrict European immigration—which mainly consists in money-spending travellers of the upper class. While the Anglo-Saxon countries do desire to restrict

Asiatic immigration, because it comes mainly from the lowest social level, takes money instead of giving it, and by its tendency to become permanent creates an insoluble social problem.

But after all, it seems easy to exaggerate the probable antagonism of the Asiatic Powers. The principle of restriction is not unintelligible to them. Has not the "Chinese wall" passed into a proverb, and does not Japan, even now, exclude Chinese labourers and restrict the right of Europeans to hold land? Surely, friendly commercial relations with the Anglo-Saxon peoples will not lightly be sacrificed to a sentimental, or even a material, grievance arising from the adoption by them of an Oriental principle. Looking ahead, I see no reason why the purpose of the Empire, as defined above, should not come to be fully expressed in Imperial organisation and Imperial policy.

APPENDIX.

PREPARED BY P. E. LEWIN.

Summary of British and American Laws and Treaties affecting Asiatic Immigration, together with a Population Table.

NEW SOUTH WALES.

1855.—*Responsible Government.*

1861.—One Chinese passenger allowed to every 10 tons; owner or master liable to penalty of £10 for each Chinese in excess. Landing fee of £10 to be paid by each Chinese; penalty for non-payment to be paid by master or owner not exceeding £20 in addition to fee; in addition, vessel may be seized. Chinese coming by land pay £10. No certificate of naturalisation shall be granted hereafter. Governor may remit penalties. [Repealed 1867.]

1867.—Repeals whole of preceding.

1881.—One Chinese allowed to every 100 tons: penalty on master for each Chinese in excess, £100. Landing fee, £10: penalty on Chinese for non-payment, £10 in addition to fee; in default, one year's imprisonment. Penalty on master for allowing Chinese to land without payment, £50 for each. Exempts Chinese who are British subjects. In default of payment of penalties by master, vessel may be sold. [Repealed 1888.]

1888.—One Chinese allowed to every 300 tons: penalty on master for each Chinese in excess, £500. Landing fee, £100: penalty on Chinese for non-payment, £50 in addition to fee. Penalty on master for allowing Chinese to land without payment, £500 in addition to sum payable. Chinese arriving by land pay £100. No Chinese shall engage in mining without express authority. No Chinese shall be naturalised.

*1898.—Defines a prohibited immigrant as one who "shall fail to write out in his own handwriting, in some European language, an application to the Colonial Secretary," in a form set out from time to time. Unlawful entry punished by deportation, or imprisonment not exceeding six months. Master and owner liable to penalty of £100 for landing prohibited immigrant: total penalties not to exceed £5,000. Penalty for contravention of the Act, where no higher penalty, shall not exceed £50, or imprisonment for not more than three months.

VICTORIA.

1855.—*Responsible Government.*

1855.—Chinese immigrants shall pay landing fee of £10 each. The money received in landing fees to be placed in a special fund "towards the relief, support and maintenance of any such immigrants." Governor may make rules for management and good government of immigrants. Governor may impose an annual tax of 20s. on each immigrant for payment of officers carrying out Act. One passenger allowed to every 10 tons of tonnage of ship. Passengers to include master and crew. Owner, master or charterer carrying immigrants [Chinese] in excess liable to penalty of £10 for each Chinese carried in excess. [Repealed 1859.]

1857.—Chinese residents to pay a license fee of £1, to be renewed bi-monthly, in addition to landing fee of £10. Chinese residing without license enable to sue. [Repealed 1859.]

1859.—Chinese arriving by ship to pay £10; arriving by land £4. Residence license to be £4 per annum. One passenger allowed to every ten tons; penalty payable by owner or master on each Chinese carried in excess £10. Penalty payable by master for allowing Chinese to land without payment to be £20 for each. Chinese without license unable to sue. Governor may remit penalties. Governor may order immigrants sentenced to imprisonment to labour on public works. [Sections 10-17 relating to residence license repealed 1862, rest repealed 1864.]

1862.—Repeals residence license fee. [Repealed 1864.]

1863.—Repeals sections of 1859 Act relating to entrance fees and business license fees, for two years. [Repealed 1864.]

1864.—Chinese arriving by ship pay landing fee of £10; arriving by land pay £4. One passenger allowed to every 10 tons; penalty on owner or master for each Chinese in excess, £10. Master liable to penalty not exceeding £20 in addition to landing fee on each Chinese allowed to land without payment. Chinese so landing liable to penalty of £10 in addition to landing fee. Governor may remit penalties. Imprisoned Chinese may be put to labour on public works. [Repealed 1865.

1865.—Governor may register, or remove from any district all or any Chinese immigrants. Repeals whole

Act of 1864. Master to present list of Chinese; penalty for not doing so not to exceed £200. [Sections 4–9, repealed 1888. Repealed 1890.]

1881.—Chinese pay landing fee of £10 each; penalty for landing without payment £10, and in default imprisonment for 12 months. One Chinese allowed to every 100 tons; owner or master liable to a penalty of £100 for each Chinese carried in excess. Chinese who are British subjects wholly exempt. Chinese names omitted from voters' lists, unless British subjects.

1888.—One Chinese allowed to every 500 tons; owner or master liable to penalty of £500 for each Chinese in excess. Chinese landing without permit subject master to penalty of not more than £100. Chinese landing to obtain written permit; penalty for not possessing this £5 to £20, and, in addition or substitution, deportation; this section only operates during pleasure of Governor in Council. Act does not apply to Chinese who are naturalised in Victoria. Vessel may be sold in default of payment of penalties by master or owner. No landing fee. [Repealed 1890.]

1890.—Same.

Queensland.

1859.—*Responsible Government.*

1867.—No Asiatic or African alien shall be entitled to be naturalised, unless he has resided with his wife in the colony for three years.

1877.—One Chinese passenger to every 10 tons: penalty on master not exceeding £10 for each Chinese in excess. Landing fee, £10: penalty on master for non-payment, £20 for each Chinese and landing fee, and forfeiture of vessel. Chinese arriving by land pay £10. Chinese departing, within three years, have money refunded under certain conditions. [Sections 3, 6 and 7, repealed 1884; Sections 4, 5, 8 and 11 (amended), repealed 1884 and 1888.]

1877.—Sum payable by Asiatic or African alien for miner's right £3, and for business license £10.

1878.—No miner's right issued to any Asiatic or African alien shall be available for any new goldfield.

1884.—Repeals provisions relating to landing fee Act of 1877. One Chinese passenger allowed to every 50 tons; penalty of £30 for each Chinese in excess. Landing fee £30; penalty for non-payment £30. Chinese arriving by land pay £30. [Repealed 1888.]

1885.—Aboriginal natives of Australia, India, China, or South Sea Islands shall not vote as freeholders at Parliamentary elections.

1888.—Repeals Acts of 1877 and 1884. Exempts Chinese born in Queensland. Governor may exempt by proclamation. One Chinese passenger allowed to every 500 tons; penalty of £500 for each Chinese in excess; in default, imprisonment for 12 months. Penalty for unauthorised landing £50; in default, imprisonment for six months. Ship may be sold in default of payment of penalties. Crew to be mustered; penalty on master for absence of any Chinese £500; in default, imprisonment.

1890.—Removes penalty of imprisonment of master in case of absence of Chinese member of crew.

1892.—Asiatics or Africans shall not be employed on construction of railways under joint-stock company.

1899.—Aborigines Protection, restricting employment of natives by Asiatic or African aliens.

1899.—Regulating pearl-shell fisheries, restrictions in favour of British subjects.

Western Australia.

1874.—"Imported Labour Registry Act." See Act of 1882. [Repealed 1882.]

1882.—Natives of India, China, Africa, and of the islands in the Indian and Pacific oceans, and Malay Archipelago shall only be employed under contract; penalty on employer, £5. Labourer to be returned on expiration. Penalty on master of ship furnishing false list £100. Contract may be rescinded by mutual consent.

1884.—Amends former Act and provides fresh penalties. Contract not to exceed 3 years, and to be entered upon previous to shipment. Magistrate to keep "Imported Labour Registry Book;" he may annul contract and fine employer guilty of fraud or force. Contract may be rescinded by mutual consent, or may be renewed. Penalty for employing labourer without contract, £5 to £20. Re-enacts main provisions of Act of 1882 and applies them to the same class of alien. Compulsory repatriation at employer's expense on expiry of contract. [Repealed 1897.]

1886.—One Chinese allowed to every 50 tons; penalty of £100 for each Chinese in excess. Landing fee, £10 for each Chinese; penalty not exceeding £50 for each in addition to fee; in default, vessel shall be forfeited. Chinese arriving by land pay £10. Penalty on Chinese for non-payment not to exceed £20 in addition to fee; in default, liable imprisonment for 12 months. Exempts British subjects. [Repealed 1889.]

1889.—Repeals last Act. Exempts certain persons, *i.e.* labourers brought into colony under contract. One Chinese allowed for every 500 tons; penalty £500 for each Chinese in excess. Chinese entering by land without permit liable to penalty of £5 to £20, and in addition or substitution to be deported. Abolishes poll-tax.

1890.—*Responsible Government.*

1893.—No labourer of Chinese race shall be imported under provision of Labour Registry Act of 1884. Imposes a language test: immigrant has to write out a passage in the character of any European language in English selected from an English author. Master and owner of vessel landing prohibited immigrant liable to penalty of £100 to £500. Act shall not affect "Imported Labour Registry Act of 1884." or pearl fishers.

1897.—Repeals Act of 1884. Substantially same as that Act, save no labourer shall enter colony south

of latitude 27 S, and only one labourer for every 500 tons. Penalty for assisting unlawful entry, £100, or imprisonment not exceeding 12 months; master and owner of ship liable to penalty of £100 for each labourer; vessel may be sold in default. Only labourers under contract admitted. Definition of labourer as before.

1904.—Factories Act containing special clauses relating to Chinese and other Asiatics. Clause 46 enacts that no Asiatic shall be registered as owner or occupier of a factory unless he carried on business before 1st November, 1903, or shall be employed unless so engaged before that date. Clause 13 enacts that where occupier of factory is Chinese or Asiatic, or any person employed is Asiatic, annual fee shall be £5 instead of 5s. in case of Europeans.

South Australia.

1856.—*Responsible Government.*

1857.—One passenger to every 10 tons, not more than one-sixth to be Chinese; penalty for each Chinese in excess, £10. Landing fee, £10. Penalty on master for permitting unauthorised landing, £20 for each and fee.

1881.—Does not apply to Northern Territory. Master to furnish list of Chinese; penalty for each default, £200. One Chinese allowed to every 10 tons. Penalty for each Chinese in excess, £10. Landing fee, £10. Penalty on master for non-payment of landing fee not exceeding £20 for each Chinese so landed and fee. Penalty on Chinese, £10 and fee. Chinese coming by land pay £10. [Repealed 1888.]

1888.—One Chinese to every 500 tons. Penalty of £500 for each Chinese in excess. Chinese entering by land without permit liable to penalty of £5 to £20, and in addition or substitution to deportation. Abolishes poll-tax on Chinese. Act to be in force till January 1, 1890.

1889.—Extends Act of 1888 to 1891.

1890.—Extends Act of 1888 to 1892.

1891.—Continues Act of 1888 in force. Not to apply to Chinese naturalised before October 1, 1891.

Tasmania.

1856.—*Responsible Government.*

1887.—One Chinese allowed to every 100 tons; penalty £10 for each Chinese in excess. Landing fee, £10; penalty for permitting landing without payment, £20 for each and fee, and vessel shall be forfeited. Penalty on Chinese for not paying fee, £10 and fee. Exempts British subjects.

*1898.—Defines prohibited immigrant as person who "shall fail to write out in his own handwriting in some European language, and sign an application form." Penalty for unlawful entry, imprisonment for not more than six months, in addition, or substitution, deportation. Masters and owners liable to penalty of £100 for each prohibited immigrant landed, and in addition £20 for each over number of five; penalties not to exceed £5,000. Vessel may be sold in default. Contravening act or aiding to contravene; penalty £50, or imprisonment not exceeding 3 months till penalty be paid.

Commonwealth of Australia.

1900.—"Constitution Act."—Gives the Australian Parliament powers to make laws on immigration and emigration. [Part V., Sect. XXVII.]

*1901.—Defines a prohibited immigrant as one "who fails to write out at dictation a passage of fifty words in an European language, directed by the officer;" also persons under contract to perform manual labour, and others. Unlawful entry punished by imprisonment, not more than six months, and in addition or substitution, deportation. Master and owner liable to penalty of £100 for each prohibited immigrant landed from ship: penalty for contravention, where no higher penalty, £50; in default, imprisonment not exceeding three months. Persons, not British subjects, convicted of crimes of violence may be required to pass dictation test.

*1905.—To be read with preceding Act. Makes education test as follows:—"Any person who fails to pass the dictation test—that is to say, who, when an officer dictates to him not less than fifty words in any prescribed language, fails to write them out in that language."

New Zealand.

1852-1868.—*Responsible Government developed.*

1881.—One Chinese passenger allowed to every 10 tons; penalty on master of £10 for each in excess. Landing fee, £10; penalty on master for non-payment, £20, and forfeiture of vessel. [Section 3, repealed 1888.]

1888.—One Chinese passenger allowed to every 100 tons; penalty on master for non-payment of landing fee increased to £50.

1896.—One Chinese passenger allowed to every 200 tons. Landing fee, £100.

*1899.—Defines "prohibited immigrant" as one who fails to write out, in any European language, an application form. Prohibited immigrants, unlawfully landing, liable to a penalty of £100, and to be deported; master of ship liable to penalty of £100 in respect of each prohibited immigrant landing. In default of paying penalties, vessel may be sold. Does not apply to Chinese—a special clause reserving former Acts.

1907.—Amending Act of 1881. No Chinese shall land in New Zealand "unless such Chinese is able to read a printed passage of not less than one hundred words of the English language selected at the discretion of such collector or principal officer." [Reserved.]

British Columbia.

1871.—*Entered Dominion of Canada.*

1878.—Imposes a license on Chinese to be taken out every three months on payment of 10s. Employers of Chinese to furnish list: penalty for not furnishing lists, $100 for each Chinese. Chinese not in possession of license, or person employing him,

liable to penalty of $100. Chinese without license may be set to labour on public works. [Disallowed 1879.]

1884.—Chinese not allowed to buy Crown lands.

1884.—Prohibits entry of Chinese under penalty of $50. Penalty on persons assisting to bring in Chinese, $200 for each. [Disallowed 1885.]

1884.—Imposes annual tax of $10 on Chinese for license: penalty not exceeding $40. Employer of Chinese to furnish list: penalty $100 for each Chinese. Fee for miner's right, $15 instead of $5. [Overruled by Canadian Act, 1885.]

1898.—Forbids employment of Chinese and Japanese on certain works carried on under franchises granted by private Acts passed in 1898 or subsequently. Penalty on employer, not exceeding $25 nor less than $10 for each Chinese or Japanese. Offender liable to separate and successive penalties for each and every day.

*1905.—Defines prohibited immigrant as one "who when asked to do so, fails to write out at dictation, in the characters of some language of Europe, a passage of fifty words, in an European language directed by the officer." On similar lines to other education test Acts. [Disallowed. Repealed 1905.]

*1907.—"The Immigration into British Columbia of any person who shall fail to write out and sign, in the English language, or any language of Europe, an application to the effect of the form in schedule, as well as read in English or any language of Europe any test submitted to him, shall be lawful. [*Sic.*]" [Ruled *ultra vires.*]

Dominion of Canada.

1867.—"British North America Act."—Section 95 enacts that the Legislature of each Province may make laws in relation to agriculture and immigration into the Province, and the Dominion Parliament may make laws in relation to agriculture and immigration in all or any of the Provinces. Provincial Acts to have effect as long as and as far only as they are not repugnant to Acts of the Parliament of Canada.

1885.—See next Act. [Repealed 1886.]

1886.—One Chinese immigrant allowed to every 50 tons; owner liable to penalty of $50 for each excess. Chinese pay $50 for permit; certain classes exempted, such as tourists, merchants, students: penalty on Chinese for evading Act, imprisonment not more than 12 months, or fine not more than $500, or both. Penalty on master for allowing Chinese to land without permit, $500-$1,000 for each offence, in default, imprisonment not exceeding 12 months: vessel shall be seized. [Repealed 1900.]

1887.—Amending Act. [Repealed 1900.]

1892.—Amending Act. [Repealed 1900.]

1900.—Increases landing fee to $100 for each Chinese. [Repealed 1903.]

1902.—Amending Act. [Repealed 1903.]

1903.—Increases landing fee to $500. [Repealed 1906.]

1906.—Revised Statute. Landing fee, $500.

1906.—Act adopting Anglo-Japanese Treaty of Commerce (1894).

Cape of Good Hope.

1872.—*Responsible Government.*

*1902.—Defines a prohibited immigrant as one who "shall be unable through deficient education to himself write out and sign in the characters of an European language an application to the satisfaction of the Minister." Penalty on master of ship £100, and further penalty of £20 for each prohibited immigrant in excess of five.

1904.—Prohibits entry of Chinamen. Register of Chinese to be kept, and annual certificates issued. Chinese contravening Act, liable to fine not exceeding £100; or, in default, imprisonment not exceeding one year, or both; in addition, may be deported. Assisting contravention: penalty £100, in default imprisonment not exceeding two years, or both. No certificates of naturalisation granted to Chinese. Chinese twice convicted of certain crimes to be deported.

1906.—Amending Act.

*1906.—Defines prohibited immigrant as one who "shall be unable through deficient education to himself write out and sign in the characters of any European language, &c.;" and recognises Yiddish as European language.

Orange River.

1882.—Coloured persons on diggings register monthly on fee of one shilling. Term "coloured person" not defined. [This was defined in 1907 as "any male coloured person of African birth, or descent."]

1890.—Prohibits settlement of Arabs, Chinamen, coolies, or other Asiatic coloured people, without permission of President. Forbids them to hold fixed property, or become merchants and farmers. Penalty, not exceeding £25; in default, imprisonment not exceeding three months: subsequent offence, fine and imprisonment doubled. Exempts Cape Malays.

1893.—Prohibits coloured persons to live elsewhere than in fixed locations [with exceptions]. Defines coloured persons as "men and women above 16 years of age of any native tribe in South Africa," and also all coloured persons who, "in accordance with law or custom, are called coloured persons or are treated as such, of whatever race or nationality they may be."

*1899.—Defines prohibited person as one who "shall fail to make and sign a personally written application in any European language in the form prescribed in Schedule."

1900.—*Annexed to British Empire.*

1904.—Imposes annual tax of 20s. on coloured persons of male sex between ages 18–60 [with exceptions]. Defines coloured persons as Arabs, Chinese, and other Asiatics, "and all other persons who are by law or custom in South Africa regarded as coloured." Coloured persons unable to pay shall be set to work with white master at current wages

not longer than one year. Refusal to pay entails penalty not exceeding £5; in default, imprisonment with hard labour not exceeding 3 months.

1906.—Applies more particularly to natives engaged outside colony to work in mines.

1907.—Exempts distinguished coloured visitors to colony from disabilities.

1907.—*Responsible Government.*

Transvaal.

1871.—Volksraad resolves that coloured persons may not congregate on "erven" in towns.

1884.—*London Convention provides that all persons, other than natives, will have full liberty to reside, and will not be subject to any taxes which are not imposed upon citizens of the South African Republic.*

1885.—Orders registration of persons belonging to any of the native races of Asia, including so-called coolies, Arabs, Malays, and Mohammedan subjects of Turkish Dominion, within 8 days of arrival, fee £25; penalty, fine £10 to £100; in default, imprisonment 14 days to 6 months. Registration free to those already settled. Gives Government right to appoint streets, wards, and locations for coloured persons to live in, save those living with employers. Forbids ownership of fixed property. [Section C, Article 2. Repealed 1906.]

1887.—Proclamation allowing ownership of fixed property to coloured persons in the appointed locations. Reduces registration fee to £3.

1888.—Volksraad resolution refusing coolies permission to be out after 9 p.m.

1888.—Volksraad resolution instructing Government to forbid Asiatics living in business places not in locations.

1890.—Volksraad resolution that coolies and Asiatics shall be registered by the Landdrosts.

1893.—Volksraad resolution that law of 1885 be strictly enforced; that Chinamen have special pass, fee, £25; penalty, fine not exceeding £25; in default, imprisonment not exceeding one month; for second offence, banishment. [Repealed 1903.]

1892.—Volksraad resolution that coolies, Chinese, or Asiatics, shall not trade in towns.

1898.—Government notice that coolies reside within their locations and that bazaars may be established within locations.

1900.—*Annexed to British Empire.*

*1902.—Under the Indemnity and Peace Preservation Ordinance it is enacted that no person enter without permit [with exceptions.] [Repealed 1907.]

1903.—Government notice that exemptions may be made in favour of Asiatics of certain qualification living outside the locations.

1906.—Enacts that Asiatics resident in colony, or entering, shall apply for registration; penalty fine not exceeding £100; in default, imprisonment not exceeding 3 months. Persons guilty of aiding and other offences liable to fine not exceeding £500; in default, imprisonment not exceeding 2 years, or both. Governor in Council may prescribe form of permit.

1906.—*Responsible Government.*

1907.—Re-enacts preceding law. Government notice that Asiatics shall furnish impressions of thumbs, or of thumbs and fingers.

*1907.—Repeals Peace Preservation Ordinance. Defines prohibited immigrant as one who, "when asked, whether within or outside this colony, by a duly authorised officer, shall be unable, through deficient education, to write out (from dictation, or otherwise) and sign in the characters of an European language, an application for permission to enter this colony, or such other document as such officer may require," and accepts Yiddish as European language. Does not apply to Asiatics eligible for certificate of registration, nor descendants of aboriginal races of Africa, south of Equator. Penalty on prohibited immigrants, fine not exceeding £100; in default, imprisonment not exceeding six months, or both, and deportation.

Natal.

1856.—Ordinance empowering Lieut.-Governor to make regulations for introduction of coolies. [Repealed 1870.]

1859.—License required for introduction of immigrants from territories to eastward of Cape of Good Hope, not within India. Contract service not longer than three years. Protector of Immigrants to keep register.

1859.—Immigrants from India introduced at expense of Natal Government. Immigrants assigned for not more than three years, employers to pay three-fifths of passage money. On termination of contract immigrant shall enter into fresh contract for not more than two years, which may be redeemed on payment. After five years coolie may reside and hire his services in Natal. Ten years residence entitles to free passage to India; grant of land in lieu of passage.

1859.—Persons may introduce coolies at own expense. Proportion of females to be sent.

1863.—Regulates payments.

1864.—Financial arrangements. [Repealed 1871.]

1864.—Loan for introduction of coolies.

1864.—Extends terms of assignment to five years.

1864.—Regulates payments.

1865.—Amends Law 14, 1859.

1867.—Regulates wages.

1870.—Employers to pay passage of coolies and such proportion of females as may be assigned. £3 to be paid annually for each coolie. Five years contract, when coolies may reside and hire themselves, or may re-indenture. Ten years residence entitles to free passage to India. Coolies may not depart without permission. [Repealed 1891.]

1871.—Amends law of 1870. [Repealed 1874.]

1872.—Exempts Indians from corporal punishment. [Repealed 1891.]

1874.—Defines special powers of Protector of Immigrants. [Repealed 1891.]

1874.—Creates Indian Immigration Trust Board, consisting of Protector and two other members.

1875.—Confers powers of magistrate on Protector. [Repealed 1891.]

1875.—Authorises raising of Indian Volunteer Regiment, of not more than 1,300 men.

1878.—Financial. [Repealed 1881.]

1878.—Amends law of 1870. [Repealed 1891.]

1878.—Creates Board of Education for Indian children.

1880.—Indian Immigration Trust Board, to consist of Protector and four other members.

1881.—Repeals sections of laws. [Repealed 1891.]

1882.—Extends Acts to outlying districts. [Repealed 1891.]

1883.—Franchise: persons subject to special laws and tribunals not entitled to vote without special exemption.

1890.—Regulating sale of liquor to Indians.

1891.—Re-enacts in 119 sections main provisions of law of 1870, with special provisions as to marriage, divorce, adultery, &c., of Indians.

1893.—*Responsible Government.*

1894.—General revenue shall not contribute to cost of Indian immigration.

1894.—Persons of Asiatic race not qualified to vote, save those already on the register. [Repealed 1896.]

1895.—Contracts to contain clause that Indians either return to India or remain in Natal under new indentures at graduated wages. Indians returning at expiration of contract entitled to free passage. Indians not returning pay yearly license of £3.

1895.—Indian Immigration Trust Board to be elected by registered employers of Indians.

*1896.—Disqualifies as electors persons belonging to countries not possessing elective institutions.

1896.—Regulates sale of liquor to Indians.

*1897.—Dealers' licenses not to be issued to persons unable to keep books in English. Gives appointment of licensing officers to local councils from whom there shall be no appeal.

*1897.—Defines "prohibited immigrant" as any person who "when asked to do so by an officer shall fail to himself write out and sign, in the characters of any language of Europe, an application to the Colonial Secretary in the form set out in Schedule." Unlawful entry punished by deportation or imprisonment not exceeding six months. Masters and owners of ships liable to penalty of not less than £100, which may be increased up to £5,000 by sums of £100 for every five prohibited immigrants after the first five. [Repealed 1903.]

1901.—Regulates wages of Indian women.

1901.—Extends Indian Immigration Laws to Zululand.

1902.—Financial.

1903.—Applies to children of Indian immigrants. Children upon reaching majority (16 and 13) shall be obliged to (*a*) go to India; (*b*) indenture in Natal, or (*c*) pay for yearly license.

*1903.—Defines prohibited immigrant as any person who "when asked to do so by any officer shall be unable, through deficient education, to himself write out and sign, in the characters of some European language, an application to the satisfaction of the Minister." Re-enacts main provisions of Act of 1897. Penalty on master, and owner of ship, £25 to £100 in respect of each prohibited immigrant landed.

1904.—Refers to transit labourers passing to other colonies.

1904.—Negotiable documents cannot be signed by Indians, unless written in English.

1904.—Imposes a poll-tax of one pound on every male of 18 years and upwards, save (*i.e.*) Indians under indentures.

1905.—Indians may re-indenture for not more than five years, nor less than two.

NOTE.—Statutes marked * are of general application. Otherwise their application is specific.

INDIA.

1883.—The "Indian Emigration Act."—Repeals Acts of 1871 and 1872. Emigration denotes the departure from India of a native of India under agreement to labour in some country beyond India. Emigration to be confined to certain ports and to countries duly notified. Protector of Emigrants shall aid and advise emigrants, enquire into their treatment, and see that Act is enforced. Emigrants not allowed to depart without pass; penalty for unlawful recruiting, fine not exceeding Rs. 500. Master receiving emigrants on board in contravention of Act liable to imprisonment not exceeding one year or fine not exceeding Rs. 1,000 for each emigrant, or both. Governor-General may make regulations.

UNITED KINGDOM AND CHINA.

1842.—*Nanking Treaty.*—A treaty of peace and friendship, under which subjects of either nation shall enjoy security and protection in the dominions of the other.

1860.—*Peking Convention.*—Clause 5 provides that Chinese may take service in British Colonies, and that regulations for their protection shall be framed.

1866.—*Convention to Regulate the Engagement of Chinese Emigrants by British and French Subjects.*—Not ratified. Frames regulations with respect to registration, contracts of service, and return of emigrants.

1904.—*Convention respecting Employment of Chinese Labour in British Colonies.*—Frames the regulations mentioned in the Peking Convention of 1860, which had not been drawn up. Indentures shall specify name of country, duration of engagement, nature of work, rate of wages, &c. Convention to remain in force for four years.

United Kingdom and Japan.

1894.—*Treaty of Commerce and Navigation.*—Agrees that subjects of either nation shall have "full liberty to enter, travel, or reside in any part of the dominions and possessions of the other," and shall not be subject to higher imposts or charges than native subjects or subjects of the most-favoured nation, and shall have full right of trade. By Article XIX. this treaty "shall be applicable, so far as the laws permit, to all the Colonies and foreign possessions of Her Britannic Majesty, excepting to" India, the Cape, Victoria, South Australia, Natal, Western Australia, New Zealand, Queensland, Newfoundland, Tasmania, and Canada; but may be adopted by them on due notice within two years. Treaty does not take effect till five years after signature, and remains in force for twelve years.

1897.—Protocol providing for accession of Queensland to the Commercial Treaty with Japan was signed at Tokio. Agreed that "the stipulations regarding right of entry, travel, &c., shall not in any way affect the laws, ordinances, and regulations with regard to trade, the immigration of labourers and artisans, police and police security, which are in force or may hereafter be enacted in Japan or in Queensland," and that "the treaty shall cease to be binding at the expiration of twelve months after notice shall have been given on either side."

1897 (March 17th).—Exchange of Notes at Tokio, between Sir Ernest Satow and Count Okuma. Japan undertakes to enter into Convention with any of the other Colonies or Possessions, scheduled in Act XIX. of 1894 Treaty, on same terms as those of the Queensland Protocol.

1906.—Canada agreed (Jan. 31) to adopt Treaty of 1894.

1907.—Viscount Hayashi, writing to Mr. Lemieux, Canadian Minister for Labour, December 23rd, 1907—"I have the honour to state that although the existing Treaty between Japan and Canada absolutely guarantees to Japanese subjects full liberty to enter, travel, and reside in any part of the Dominion of Canada, yet it is not the intention of the Imperial Government (Japan) to insist upon the complete enjoyment of the rights and privileges guaranteed by those stipulations where that would involve disregard of special conditions which may prevail in Canada from time to time."

United States and China.

1868.—*The Burlingame Treaty.* — Recognised the "mutual advantage of the free migration and emigration of their citizens from one country to the other, for purposes of curiosity, of trade, or as permanent residents." Guaranteed to Chinese subjects residing in or visiting the United States the same privileges that were enjoyed by the most-favoured nations.

1880.—Treaty agreeing that whenever in the opinion of the United States Government the coming of Chinese labourers affects the interests of the United States or of any locality within its territory, the United States Government may "regulate, limit, or suspend such coming or residence, but may not absolutely prohibit it." Limitation shall be reasonable.

1882.—*Statute.* — Suspends entry of Chinese labourers for period of ten years. Master of vessel liable to fine of not more than $500 for each Chinese and may be imprisoned for not more than one year. Chinese already in States may obtain certificate entitling to return. Chinese unlawfully in States shall be deported. Chinese may not be admitted to citizenship. [Repealed 1888.]

1884.—*Statute* (Amending). — Re-enacts prohibition clause. [Repealed 1888.]

1888.—*The Bayard Treaty.*—Not passed by Senate. Agreed that for twenty years coming of Chinese labourers be suspended and exempts Chinese officials, students, teachers, merchants, and travellers. Refuses right of naturalisation.

1888.—*Statute.*—Prohibits entry of Chinese person, whether subject of China or any other power, except officials, teachers, students, merchants, or travellers coming with certificate. This section to become operative on ratification of Bayard Treaty, which was not ratified. Chinese labourer not permitted to return unless he has lawful wife, child, or parent in United States, or property of value of $1,000. Penalty on master of vessel, not less than $500 nor more than $1,000 for each Chinese, and may be imprisoned for not less than one nor more than five years. Chinese unlawfully in States may be deported.

1888.—*Statute.* — Prohibits return of Chinese labourers having left United States, and makes existing certificates void.

1892.—*Statute.*—Extends all laws in force relating to regulation or suspension of Chinese immigration for period of ten years. Chinese unlawfully in United States shall be imprisoned with hard labour for period not exceeding one year, and deportation. [Declared void.] Resident labourers to be certificated; deportation unless valid excuse.

1893.—*Statute.*—Defines term "labourer."

1894.—Convention agreeing that for ten years the coming of Chinese labourers shall be prohibited. Convention may be extended for another ten years if not terminated by six months' notice.

1894.—*Statute.*—Decision of immigration officer may be reversed on appeal to Secretary of Treasury.

1898.—*Statute.* — Prohibits entry of Chinese labourers into Hawaii except under laws of United States.

1900.—*Statute.* — Prohibits entry of Chinese labourers from Hawaii.

1903. — *Commercial Treaty.* — Agrees that all treaties in force on 1st January, 1900, are continued in full force.

1904.—Dec. 8.—Convention of 1894 denounced by China, leaving in force the Treaty of 1880.

POPULATION TABLE.

Colony.	Date.	Chinese.			Japanese.			British Asiatics.			Other Asiatics.			Total Asiatics.			Approximate white population.	Relation per cent.	Notes.
		M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.			
Total Australian Colonies	1861	38,287	11	38,298	..	..	..	..	..	..	..	..	..	..	..	..	1,113,322	3·4	Highest. Lowest.
	1871	28,338	44	28,382	..	..	..	..	..	..	..	..	..	..	..	..	1,646,596	2·3	1881... Q'land 5·8 ... W.A.?
	1881	38,243	154	38,397	..	..	..	..	..	..	..	..	..	..	..	..	2,119,380	1·8	Tas. 0·7
	1891	34,883	352	35,235	..	..	..	..	..	..	..	..	..	..	..	..	3,138,974	1·1	
	1901	29,463	374	29,837	3,154	417	3,571	7,388	1,796	9,184	2,741	145	2,886	42,746	2,732	45,478	3,731,428	1·2	1901... Q'land 2·8 ... Tas. 0·5
	1907	27,760	440	28,200	2,848	436	3,284	7,690	1,926	9,616	2,780	195	2,975	41,078	2,997	44,075	4,190,000	1·05	W. A. 2·7 ...
New Zealand.	1871	2,633	4	2,637	..	..	..	..	..	..	..	..	..	..	..	..	253,756	1·03	(j) Does not include Europeans born in India, of whom there are 1,156.
	1881	5,017	16	5,033	..	..	..	..	..	..	..	..	..	..	..	..	484,900	1·003	
	1891	4,446	24	4,470	..	..	..	..	..	..	..	..	..	..	..	..	622,188	0·7	
	1901	2,819	17	2,836	10	7	17	21	3	j 24	100	52	152	2,950	79	3,029	769,690	0·3	(g) By nationality.
Natal	1881	..	..	..	..	..	..	13,626	6,570	20,196	..	..	..	..	..	..	29,113	69·0	(l) Of these, 30,393 were not under indenture and 19,119 of them were from India.
	1891	..	..	77	..	..	..	25,686	15,456	lg 41,142	..	..	18	..	..	41,236	46,788	88·1	(k) Including Japanese.
	1904	167	4	k 171	..	..	..	63,311	37,416	g 100,727	19	1	20	63,497	37,421	100,918	97,109	103·9	Estimate.
	1906	..	..	..	..	..	..	70,726	41,400	g 112,126	..	..	..	..	..	..	94,370	118·8	
Cape Colony	1875	..	..	..	..	..	..	180	96	276	38	34	72	218	130	348	237,252	·01	Does not include Cape Malays, of whom there are (1904) 15,138 born in Austraial.
	1891	..	..	..	..	..	..	259	160	419	59	16	75	318	176	494	376,987	·01	
	1904	1,339	7	1,346	..	..	..	8,348	518	8,866	469	150	619	10,156	675	10,831	579,741	1·7	
Transvaal	1904*	871	3	874	..	..	..	8,234	694	8,928	356	190	546	9,461	878	10,348	†298,167	3·4	* Census. † Excluding repatriable indentured Chinese.
	1907	1,258	..	..	8	..	..	12,375	..	..	..	..	..	‡13,641	..	..	..	..	‡ Number of permits issued to male Asiatics between Dec. 4, 1902, and Nov. 30, 1907. On Jan. 4, 1908, Transvaal Government estimated 14,500 including 5,000 unauthorised who had lately left the Colony.
Orange River Colony	1904	5	2	7	..	..	..	210	48	458	40	18	58	255	108	363	†142,679	·02	
Total British S.A.	1904	2,382	16	2,398	..	..	..	80,103	38,676	118,779	884	359	1,243	83,369	39,051	122,420	1,117,696	10·9	
British Columbia	1881	..	..	g 4,550	..	..	..	..	..	..	..	..	..	..	..	..	40,459	10·7	
	1891	..	..	8,910	..	..	..	..	..	..	..	..	..	..	..	..	89,263	9·8	
	1901	..	..	14,576	..	..	4,515	..	..	..	..	..	..	..	..	..	159,566	11·9	
	1908	..	..	16,000	..	..	11,000	..	2,500	..	..	..	..	..	..	29,500	*200,000	14·75	* Official Estimate, 1906.
Rest of Canada.	1881	..	..	33	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
	1891	..	..	219	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
	1901	..	..	2,467	..	..	159	..	..	..	..	..	..	..	..	..	..	..	
Total Domin'n of Canada	1901	..	..	17,045	..	..	4,674	..	..	..	..	..	..	..	..	21,717	5,349,598	·4	Does not include British Asiatics.

United States and Japan.

1894.—*Treaty of Commerce and Navigation.*—Subjects of each nation shall have full liberty "to enter, travel, or reside in any part of the territories of the other contracting party," and shall pay no charges or taxes higher than those paid by subjects of most-favoured nation. Stipulations do not affect any laws with regard to trade, the immigration of labourers, &c., which "are in force or may hereafter be enacted in either of the two countries."

United States—General Legislation.

1907.—An Act to regulate the immigration of aliens. Imposes a tax of $4 on every alien entering the United States except those who have resided one year immediately preceding in Canada, Newfoundland, Cuba or Mexico, and aliens in transit. Exception does not apply to aliens arriving in Guam, Porto Rico, or Hawaii. Provided further that "whenever the President shall be satisfied that passports issued by any foreign government to its citizens to go to any other country than the United States, or to any other insular possession of the United States, or to the Canal zone, are being used for the purpose of enabling the holders to come to the continental territory to the detriment of labour conditions therein, the President may refuse to permit such citizens to enter the continental territory."

Section 36 provides that aliens who shall enter the United States except at the seaports or at such places as may be designated shall be adjudged to have entered unlawfully.

DISCUSSION.

The Chairman (the Right Hon. Alfred Lyttelton, M.P.) said that from the point of view of the administrator looking at actual facts the conclusion Mr. Jebb had arrived at was substantially true, namely, that the self-governing Colonies were irrevocably determined not to admit the effective competition of Asiatic races within their border. That determination had been arrived at, he thought, from two or three causes, the principal one being an industrial reason and a trade union reason, the determination that a country having been won by the efforts and the struggle of a white race and rescued from barbarism should not be made the ground of competition by men who had not been engaged in that struggle. The second reason referred to by Mr. Jebb was that the Asiatic races did not fuse with the white population; marriages between Asiatic races and European races were not looked upon with favour by either party. The Natal Act he did not think was in the least "slim" or anything else than the politest possible statement of a definite and effective resolve. There had been an occasion on which there had been a very strong desire on the part of a white population as a whole to have Asiatic labour under very definite and stringent restrictions, restrictions which were very much the same in West Australia and the Transvaal. Those restrictions were objected to—he was speaking scientifically—through ignorance and prejudice by those who confused free competition of Asiatic immigrants with Asiatic immigration under restriction and brought them both under one definition. Obviously there was an immense difference between a competition which was perfectly free and a competition which was restricted, and which could only continue for a comparatively short time, and in a definite and located industry. It was an objection which would always obtain amongst those who had not carefully studied the subject. There was a much more formidable objection, namely, the objection of high-minded men with ideals, who objected to planting any labour in any country under conditions in which that labour could not rise, and the labourer seek citizenship in the country. That objection was maintained against restricted immigration, even if the immigrants themselves joyfully accepted the restrictions and infinitely bettered themselves. He did not think any who had attained his own age would ever see amongst the self-governing Colonies the slightest disposition to accept Asiatic immigration unless with restrictions, and, as he had already pointed out, those restrictions were objected to on different but formidable grounds. There had been one very peculiar development in South Africa in the report of a Labour Commission appointed in the Transvaal, a Commission which not only objected, if the newspaper telegrams were correct, to Asiatic immigration competing with white labour in that country, but objected to the competition of black labour with white labour. It was a strange system of world ethics which, on the acquisition of a country by invasion and the dispossession of the aboriginal inhabitants, would dispute the right of the latter to work therein. According to the telegrams, Mr. Creswell was one of the most pronounced supporters of this peculiar doctrine, but it was to be hoped the telegrams misrepresented the report. Whether the Western nations of the world could permanently maintain the position of monopoly for themselves in the West and equal and free competition in the East was a question, which gave one serious reason for pause. In effect, the pretension of the Western nations was that they should freely compete throughout the whole East, upon terms of absolute equality, with the inhabitants of those lands, while the Easterns were to have no access whatever to the West, or to those portions of it where their competition was likely to be formidable. That pretension brought them into a strange and rather serious region of thought. "Free competition in your land; monopoly in ours"—that was the doctrine, and he quite agreed with Mr. Jebb that such a principle could only be maintained and asserted by force. And when they considered what India meant to the British Empire, and what a tremendous thing it would be if all the races in India were to unite against pretensions so paradoxical, it was doubtful whether those pretensions could be continued indefinitely. Mr. Jebb had adumbrated

the possibility of our giving something by way of compensation, such as the reservation of lands, say, in East Africa or the Egyptian Sudan, for Asiatic immigration. Still more pregnant was the suggestion —though here he entered controversial regions—that compensation might come in the form of fiscal freedom for India.

Mr. ARTHUR H. REID said he had been asked to refer to the subject, especially as it affected South Africa, where he had lived for thirty-one years, eighteen of which were spent in the Transvaal. One fact should not be lost sight of, namely, that in a country with such great distances for transportation as South Africa, cheap labour must be secured before an industry could develop. It was useless to talk about paying a white man 16s. a day to do what a native would do for 2s. It was also stupid from an economical point of view to condemn Chinese labour or any other labour, unless one was prepared to substitute European workpeople who would do as much work for the same money as the Chinese. Principles are all very well, but we are living in a practical age, and had to take a practical view of these things, and the sooner the cry about the employment of coloured labour, or Oriental labour of any description ceases in South Africa the better. He thought the restriction of the industries in South Africa and other Colonies affected the unemployed question in this country, because unless the Colonies were prosperous orders would not come over to this country for machinery and goods, and in that way the manufactures and shipping of England suffer.

Lord AMPTHILL believed the paper was one of the first attempts at a scientific study of the question, and bore evidence of careful research, originality of thought, and clear and vigorous reasoning. The title of the paper was a decided step in advance. The general public had not yet realised that there was such an Imperial problem, and it was with the greatest difficulty that Parliament was induced to listen to any discussion on the subject. It was, of course, easy to point out the gaps that were left in the argument, but, of course, it was impossible to cover everything in a short paper. The first matter in which he differed from Mr. Jebb, was with regard to his remarks about the Colonial Conference of 1897. Mr. Jebb said that the Conference in 1897 was the first effort to systematise the practice of the Empire, but he did not say that it was the final effort. The efforts should be persisted in until the system had been made as perfect as anything human could be. Mr. Jebb suggested that those who advocated another Conference had said that the Colonies had not shown sufficient sense of Imperial responsibility in the matter, but he himself, and many of those who were associated with him, had expressed their belief many times that the Colonies realised their Imperial responsibilities as much, if not more, than Great Britain herself. It was not possible to put the responsibility for any failure in Imperial statesmanship on the Government of India or on the Governments of the Colonies. The strings of Empire were gathered together in Great Britain, and the Imperial Government alone was in a position to know exactly what was going on in all parts of the Empire, and the Colonies and India had every right to expect that the Imperial Government should take the lead in all questions of that kind. The Imperial Government should collect and collate all the facts and opinions and say to the Colonies: "This is the question; here is all the evidence; it seems to us that certain general principles can be deduced from all this evidence, and these are the principles. We ask you to send representatives here or discuss it by correspondence, to see how far you will agree on these principles." But, unfortunately, Imperial statesmen were afraid of the question, for reasons that were absolutely incomprehensible to himself. He could not believe that the Colonies would resent a frank and candid expression of opinion, and he thought such an expression of opinion would result in a better understanding and a fuller agreement. Mr. Jebb had propounded an interesting theory of indigenous nationalism, but it was possible to argue the question from a still simpler theory, the rights of property. Nobody with any sense of responsibility would deny for one moment the right of the Colonies to keep their own territories to themselves; it was an elementary principle equally well understood in India, in China, and in Japan. There was no question of forcing on the Colonies any theory that immigration should be absolutely unrestricted. Even within Great Britain there were measures regulating the economical condition of labour, preventing congestion in towns, preserving the rights of property, and regulating and restricting the flow of population. The whole point was that the methods of enforcing that restriction should not be such as to give offence to Asiatic nations or to those who, though coloured, were fellow citizens of the Empire. The reason for restriction of immigration was economic, and economic pressure translated itself into a kind of race prejudice, whereas the natural and legitimate wishes of the people should be translated into the language of statesmanship. The people of India should be told there was no room for them in such and such Colonies, not because there was any prejudice against them on account of their race or colour, but simply that if they went there they would have to starve At the same time Colonial statesmen might educate their own people so that there should be no longer bursts of popular passion having the semblance of race and colour prejudice. His main objection to the paper was that Mr. Jebb ignored the position of India and had treated Indians with all other Asiatics. That was not right. A colony like Natal had been made by Indian labour and there was such a thing as gratitude, and it was impossible to ignore the debt of gratitude which Natal owed to India. If India had not made the Empire possible, Australia might at the present

moment be struggling with Japan for the possession of the Australian Continent, and, therefore, Australia also owed a debt of gratitude to India which she could only pay by recognising the Imperial citizenship of the natives of India. The Government of Great Britain should permit no action by a colony which insulted the feeling, or did an injustice to our Indian fellow citizens, and while it might be right to restrict immigration it was utterly wrong to injure the Indians who had already acquired vested rights and were already residing in the Colonies. He agreed with Mr. Jebb that a solution might be found by giving India a fiscal system like that of the self-governing Colonies and thus make her a self-governing economic unit.

The Right Hon. Sir West Ridgeway yielded to no one in sympathy and affection for India and her people, and he hoped there would be no misapprehension as to his attitude in the remarks he had to make. He would confine himself to what the author called the interior aspect of the question, namely, the question so far as it concerned the Empire within itself. He understood that the claim which was urged on behalf of our Asiatic fellow-subjects was the right of unrestricted and free entry to all parts of the Empire, and to live there without being subject to any disabilities. That claim was based on what was called Imperial citizenship, and if the definition given by the author was accepted, he entirely agreed with it; but if Imperial citizenship was to involve the right of all Asiatic subjects to free entry and residence in all parts of the Empire, then it was impossible. The self-governing Colonies would not accept that policy, and to force them to do so would mean disruption of the Empire. Not only was the policy impossible, but it was inexpedient, because it was not just. If there should be an inconvenient immigration of Asiatics into the United Kingdom, it would be prevented and restricted by legislation, and if restriction was justifiable in the mother country, *a fortiori* it was justifiable in outlying self-governing Colonies that were struggling to maintain their supremacy and nationality. Lord Ampthill recommended a conference at which the Imperial Gavernment was to propose a policy. He should like to have heard Lord Ampthill define that policy. Was Great Britain to advise the self-governing Colonies that there should be unrestricted immigration into their territories, or, if there was that restriction, what was to be the nature and extent of that restriction? There could be no uniform policy. Immigration might be safely allowed in some self-governing Colonies—Queensland, for instance—that would be considered inexpediant and unsafe in other Colonies. There could be only one judge of the matter, and that was the self-governing Colony itself, and we might try by kindly advice and persuasion to influence, but it was a mistake and undignified to scold and hinder. But that was a different question from the tieatment of Asiatic fellow-subjects once they had been allowed to settle, or their ancestors had been allowed to settle, in any self-governing Colony. Then the Imperial Government had a right to expect that they should be justly treated, and not subjected to any unnecessary disabilities, political or social. There was no doubt that in South Africa they were subject to certain social disabilities appropriate enough in the case of the half naked, dirty, uncivilised Kaffir, but totally inappropriate in the case of the clean, well-dressed, Indian trader. He was sure that all men of light and leading were willing to give representation to the better class of natives consistent with the indispensable principle that where there were mixed races, the white man must be predominant. He could not see any objection to indentured labour, even when it involved repatriation, provided the condition of repatriation was realised by the labourer and agreed to by him, and that he returned to his country with money in his pocket, and not in a state of destitution.

Mr. J. D. Rees, M.P., strongly concurred with everything Sir West Ridgeway had said, both with regard to his deep sympathy with the inhabitants of India, and with his view as a practical statesman, who knew the impossibility and folly of endeavouring to dictate to the Colonies in the matter under discussion that we should not attempt to coerce Colonial governments. He had been a member of the Committee formed for the purpose of dealing with the question of Indian immigration into South Africa, but he left the Committee immediately he was convinced that it was doing no good to the Indians and annoying the Colonists. While we pretended to be Free Traders with regard to everything, we were, none of us, Free Traders with regard to labour. He was in favour of plainly owning that we meant to protect our own white labour and that we could not object to similar action on the part of our Colonies. We could not dictate to a self-governing Colony, and had to let the colony do what it liked. There was no stigma in registration in South Africa, and no harm in finger prints. He objected altogether to the policy of Imperialism laid before the meeting by Lord Ampthill, which he held was no Imperialism at all, but likely to dissolve the Empire. The British Empire was not an Empire in the sense in which the word was used for any other Empire; it was merely an aggregate of self-governing or other communities, and the way to break up that Empire would be an attempt of any one part of it to impose conditions upon another. He had to demur to the sort of underlying note of the paper that democracy was the form of government suitable to all parts of the Empire. He could not understand why it should be supposed that the form of Government suitable in these islands should be acceptable in any other part of the world, or why we should proceed on the assumption that the principles on which Great Britain was governed, were the principles likely to be accepted everywhere else. There was no reason

for, but only reason against, the probability that what was good for a parish in an Atlantic island was good for a dominion in America, an Empire in Asia, or a Colony in Africa.

Mr. RICHARD JEBB, in reply, said that with regard to the principal objection to Asiatic immigration being an economic one, he had tried to explain in the paper that he thought there was ample evidence to show that it was not purely an economic question, but a social question. In all the Colonies there were men objecting to Asiatic immigration who were hostile to labour. With regard to the report of the Labour Commission in the Transvaal, he had not been able to refer to it because he could not go into the details, but the attitude which Mr. Creswell represented signified the Australian influence on South Africa, as Mr. Creswell himself was an Australian. In Johannesburg there had been an attempt, no doubt, made by Australians to establish their Australian ideal, but having regard to local conditions the South African ideal would never be the Australian one on the labour question. The national ideal of South Africa had a place in it for the natives, and even the Boers had a strong sense for the welfare of the natives. Another point made by Mr. Lyttelton was that if the policy put forward rested in the last resort upon force it was very doubtful whether it could be maintained, and Mr. Lyttelton described the policy as free competition for us in Asia, and restricted competition for Asia in this country. He (Mr. Jebb) dissociated himself from that position. He conceded the right of reciprocity; as we treated Japan or China, so let those countries treat us. Let us make India economically the equal of a self-governing Colony without regard to its effect upon our trade, just as we had made the self-governing Dominions without regard to the effect upon our trade. Some feared that in such a case the trade with the East would disappear. Very likely a great deal of the trade with foreign countries in the East could be lost, but what was lost outside the Empire would be made up by increased trade within the Empire. The line he had taken that evening was part of a comprehensive Imperial policy and not a detached idea for dealing with the particular question under discussion. His idea was that if India did become a fiscal unit she would express her allegiance to the Empire by preference in the same way that the self-governing Dominions express theirs. Lord Ampthill seemed to have got the impression that he objected to this question being discussed at the Conference, and pointed out that the 1897 Conference was not only the first discussion but the last. That was true; but he did not think much good came of such discussions unless there was something definite to put forward. In 1897 Mr. Chamberlain had a definite proposition that the Empire should adopt the Natal Act as a principle of policy, and it was usefully discussed. There had been no discussion since then because nobody else had had anything definite to propose, until Mr. Mackenzie King came over. Mr. Mackenzie King presumably did not come without knowing exactly what he wanted and how he proposed to get it, and he hoped he had got it. If for the next Conference anybody could put forward some new idea it would no doubt be discussed. With regard to the Government of India not fully realising the importance of the 1897 Conference, Lord Curzon made a speech in the House of Lords in which he seemed to take credit to himself for having blocked the Transvaal Government when they wanted to have 10,000 Indians on terms of repatriation for railway work. Lord Curzon said he took that opportunity to urge upon the Transvaal Government that they should remove the disabilities on the Indians already there and proposed that the whole system of registration should be done away with as a condition. That showed either an entire lack of sympathy with the object of the South African policy or an entire failure to appreciate the practical difficulties that made registration absolutely necessary. The argument about gratitude was a very dangerous one. When the Indian Government allowed coolies to go to Natal it did not do so for the benefit of Natal but for the benefit of the coolies. The argument of gratitude once admitted met one at every turn. He did not think that either Natal or Australia owed any debt of gratitude whatever to India. The time had passed when we could say that the self-governing Dominions must compromise, because they could not enforce their policy without our aid. At the present day, Australia was able to enforce her policy either with the aid of her Imperial partners or with the aid of a foreign country, and the people of Great Britain had to make up their minds whether by falling into line with the policy of the Dominions they were going to maintain their hegemony of the Empire, or whether by not appearing to sympathise with the national ambitions of the Dominions they were going to throw the Dominions into the arms of the United States.

The CHAIRMAN proposed a vote of thanks to Mr. Jebb for his valuable paper, and the resolution was carried unanimously.

Sir JOHN CAMERON LAMB, C.B., C.M.G., thought all would join him in cordially thanking Mr. Lyttelton for taking the chair. He did not agree with him in regard to the question of protection in India, but felt that they owed him a debt of gratitude for being present that day.

Mr. J. D. ANDERSON, I.C.S. (retired), writes:—Mr. Jebb's admirable paper and his Chairman's suggestive and illuminating comments on it will furnish interesting food for thought. But many Anglo-Indians will wish that Mr. Lyttleton had spoken *sans comparaison,—comme le valet de la comédie*! Why compare the status of white men in the East with that of Orientals in the Colonies? Why suggest —at a time when India has her ears pricked up for

fresh grievances—that British privilege in the East must be bought either by making a new India of East Africa (a thing no Indian desires), or by conceding fiscal freedom to India (a thing which, if it be feasible and desirable, will certainly not be regarded either as as an equivalent or a concession)? Protection may be a good thing for India. It is possible that the *swadeshi* agitation is in effect a demand for Protection. But what has that to do with the question of Asiatic migration to Australia, South Africa, and Canada? That problem is quite sufficiently complicated without dragging in other burning questions by the ears. It is not merely that *toute comparaison cloche*, but this particular comparison is a peculiarly dangerous one at the present time. The Briton in the East is not a settler. Climate and social conditions render that impossible. He does not desire to mingle his blood with that of the Oriental or, in any proper sense, to compete with him. He performs duties, administrative and commercial, which, but for him, would not be performed at all. This is not the time to ask whether his "mandate" is exhausted. The question is simply whether Indians and other Asiatics should be treated as "interlopers" in the Colonies, just as Europeans were treated as "interlopers" and were expelled from India a couple of generations ago. The exclusion would only be temporary and would be confined to the struggling infancy of Colonial communities. May I venture to suggest to Mr. Jebb that he might, to his comfort, add a fourth maritime zone to the three he has invented—a South Atlantic Zone, where, in Central and Southern America, is arising a real new India, where Orientals receive a hearty welcome, and where there is room and to spare for the surplus labour of India and especially for married men with families?* Does not the true remedy consist in the energetic development of tropical colonies, and in inducing educated Indians to take an intelligent interest in them? In conclusion, may I make a comparison of my own, less painful, I hope, to Indian *amour propre* than Mr. Lyttleton's? Is not the colour exclusiveness of new colonies an exact reproduction of the doctrine of the four *varnas* or "colours" on which the modern caste system of India is based? By means of it the fair-skinned Aryan invaders of India strove to keep themselves unspotted from indigenous contamination. Ethnologically they failed, and were bound to fail. But by means of that doctrine they conferred upon Northern India the existing Aryan languages, and on the whole of India an Aryan religion and Aryan institutions. It could easily be shown that the survival of Vedantic philosophy is due to the fact that, at the beginnings of their settlement in India, the Aryans were able, by means of their doctrine of *varnas*, to keep themselves from being overwhelmed by the dusky millions that surrounded them. No intelligent Indian will say that their exclusiveness was other than beneficial to themselves and to the country at large. If they had been immediately absorbed, we might now see an India on an intellectual and moral level with the few animistic tribes who have still evaded the Aryan system and the Aryan languages which are automatically learned by all races which, by becoming Hindu, become the adopted children of the once exclusive Aryan invaders. There was a time when caste was considered by Europeans to be a perverse and irrational social system, abounding in unjust inequalities. But educated Indians recognise, as a historical fact, that its very inequalities saved early India from relapsing into a dead level of savagery. I do not insist upon a comparison which obviously has its weak points. But, comparison for comparison, I venture to prefer mine to one which drags in fiscal Home Rule for India and incidentally seems to assail European administration in tropical countries.

* The West Indian and other tropical dependencies to which Indian labourers have been emigrated with marked advantage seem to illustrate the policy of the former "Indian Zone." rather than a fourth variety. But this important branch of Asiatic immigration has had to be extruded from a paper strictly confined to the "Imperial problem."—R. J.

Mr. Arthur H. Reid writes:—It is a far cry back to the time when the first Asiatic placed his foot upon South African soil, and strange to say the necessity for his introduction by the Old Dutch East India Company arose from the same cause as it arises to-day, from the disinclination of the African aboriginal to work and his remarkable ability to live without work. Mr. Liebbrandt, the Cape historian, records the fact in his précis of the Cape Archives that, despairing of inducing the Hottentots who were the original inhabitants of the Cape of Good Hope proper, to work, the Dutch East India Company imported Chinese and Malay labourers from their possessions in the East. Natal in her infancy had a similar experience, and when she was so far developed as to start tea, sugar, and other plantations, the colonists found that when the hard work of cutting the cane was required the Kafir preferred to visit his kraal. In despair, they too had to look around for other reliable labour, and India was the country to provide it. Indeed, there can be no doubt that without Indian labour the industries named would not have thrived and enriched the colonists and the Indians as they have. Twenty years ago the discovery of gold in the Transvaal once more produced a demand for cheap native labour, and for some years the local supply was sufficient, but, as the industry increased, it was found that on account of the short term of service upon which alone the Kafirs engage themselves on the mines, the normal and continuous supply was maintained with the utmost difficulty. Trouble was experienced even by the municipal and other public bodies in securing labour for street-making and sanitary service, and in despair they had to look for outside labour. Once again the Indian was called in to meet the want, and many left their work in Natal to secure the higher wages offered in the Transvaal Republic. Then came the Boer war, by which the natives did so

well that thousands of them retired to their homes, bought wives, and lived as I think only a Kafir can under such circumstances. The war being over, an extraordinary demand for unskilled labour naturally arose, but it was not forthcoming. In despair the mining companies had to look around for help, and this time China was, for two good reasons, selected as a source. In the meantime, however, the keen-witted Indian had been silently watching his chance to invade the rich Transvaal, and thousands poured over the borders from the Portuguese and other East and South African States. These, however, were not "workers," but pedlars, small shop-keepers, and petty traders of all kinds. And so last year the Transvaal awoke to the fact that it supported over 50,000 Chinese miners and about 12,000 male and female Indians, mostly petty traders. while Natal employed 112,000 male and female Indians, some on the plantations, some on the railways and public works, but a too large proportion were engaged in trade with the natives to the detriment of the white retailer and the native. We have now only the future to deal with, and in anticipating the position it would seem that we, as colonists, have to live with a limited number of a superior class of British Indians at all events. What will happen to Chinese, Japanese, and other future aspirants to a share in our prosperity has yet to be seen. Mr. Ghandi's claim that discretion in the selection and treatment of Indian immigrants, combined with due respect to the educated class, will be the only successful check, seems reasonable, especially in view of his undertaking to co-operate with the Government on those lines. The Indian labourer has done much towards the development of industries in Natal, and in return has been paid what was agreed, so that account is closed; but I am convinced that he should understand clearly that, when his services are not required, he and his family must return to the land of their birth. The Indian or Asiatic hawker and shopkeeper is *not* wanted in South Africa. The colonists can do that business very well themselves, and require no outside help!

PEKING CLOISONNÉ WARE.

Probably the finest quality of *cloisonné* ware now manufactured is that which comes from Peking, according to a recent report on the subject by the American Consul at Tsingtau. The Industrial Mission Depot, a branch of the Peking Industrial Institute, has recently been opened at Shanghai, where a large supply of *cloisonné* is always on hand, and where vases, bowls, jars, plates, boxes, incense-burners, waterpipes, umbrella-handles, cigar-boxes. napkin-rings, &c., can be purchased at any time. The *cloisonné* exhibit at the Peking Industrial Institute was awarded a Gold Medal at the St. Louis Exhibition of 1904. The following is a description of the methods adopted in the manufacture of this ware. The base, whether vase, bowl or dish, is of copper, and is obtained ready-made from the coppersmiths. The design is then etched on the copper base, and delicate cotton ribbons are shaped by means of pincers to follow the lines of the design. These are fastened into position by means of a special glue, fortified by a metallic composition, which maintains the shape of the wire tracery while it is being annealed in a primitive oven surrounded by a wire cage containing charcoal, which is kept at a red heat with fans. When cool the vase is scoured in an acid decoction and is then ready for colouring. An artist, supplied with a number of saucers containing all the colours he requires, takes the vase, and from memory, and without reference to any illustration, fills in the interstices between the wires with the proper pigments. These consist of crystals with a base of saltpetre and a kind of calcareous sandstone found in the neighbouring hills. The different colours are obtained by composition with iron pyrites, oxides of iron, or salts of lead. The coloured crystals ground to a powder are mixed with rice water, and the resulting paste forms the base of the enamel. The colours are applied by means of a small trowel, and the operation calls for great skill and dexterity. When all the spaces are filled, the vase is again baked in the oven for a certain number of minutes, as decided by the expert in charge of this operation. When cool, the vase is smoothed off with a file and returned to the colouring room, where all defects are made good. In some cases several of the spaces must be done over again; the solid vitreous colour is chipped out and the cloison refilled with paste. The vase is again baked and polished, this time with limestone, on a lathe. The retouching, rebaking, and polishing are continued until the desired result is obtained. The final lathe polishing is done with charcoal. The vase is then ready for gilding, which is done by an ordinary galvanic process, and a final polishing renders the article ready for the market.

FRENCH SAVINGS BANKS.

The French peasant and artisan have been known for many generations as the most frugal, industrious, and intelligently thrifty of European working people. Their patient industry, their love for the soil, and for their various handicrafts, and their scrupulous care of their savings form the foundations of the prosperity of France. Savings banks in France are of two classes:—(*a*) Postal or Government banks, which are established throughout the country and are under the direct management and control of the National Government; and (*b*) municipal and private savings banks which are controlled by municipalities and private firms. According to the American Consul-General in Paris, the postal savings bank system was created under a law of the 9th April, 1881, and the returns of 1882 show that during that year the

number of banks established and in operation was 6,024, with 211,580 deposit accounts remaining open on 31st December. The average sum of these deposits was about £9, and the whole amount of deposits, including interest, in all the banks at the close of the year was £1,913,000. The latest complete official statistics now available are those which record the operations of 1904, at the close of which year the number of postal savings banks in France had increased to 7,883, with 4,345,446 depositors, and deposits—including interest due to depositors on 31st December—amounting to £47,737,000. As a measure of the prosperity of rural and industrial France, it may be stated that these deposits have steadily increased, until they reached on October 31, 1907, the sum of £55,734,000—an increase of £7,997,000 within a period of thirty-four months. The postal savings banks pay interest on deposits at the rate of 2½ per cent., and the amount of each cash deposit account is limited to 1,500 francs (£60). When a depositor's account exceeds that amount the bank will purchase "Rentes" or National three per cent. bonds with the surplus, keep them on deposit, collect the coupons when they fall due, and credit the interest so received to the account of the depositor. The total deposits of 1904 in postal savings banks aggregated £18,363,000. The character of the depositors may be inferred from the fact that the average amount of each deposit account, on 31st December, was £11. The official statistics classify together, under one general category, as "Caisses d'Epargnes Privées," savings banks which are controlled by municipalities, and those which are controlled by private firms. They are based upon statutes enacted in 1835, modified in 1837, and again amended in 1845. They began operations in 1835 with 159 banks and 55 branch offices, which had in that year 121,527 deposits, and deposits amounting to £2,500,000, on 31st December, 1835. Banks, depositors, and deposits grew steadily in number and amount during the intervening sixty-nine years, until, on the last day of December, 1904, the latest date for which official statistics are available, there were in operation throughout France 550 municipal and private savings banks, and 1,461 branch offices—in all 2,011—with 7,422,326 depositors and deposits, including interest due on 31st December, 1904, amounting to the sum of £138,948,000. The average amount of each deposit account at the end of 1835 was £20 10s., it rose in 1884 to a maximnm of £24 14s., dropped in 1857 to a minimum of £11 9s., and closed in December, 1904, at £17 14s. Banks of this class pay interest on deposits ranging from 2 to 3 per cent., according to the length of time that the deposit remains undisturbed. There were thus in operation throughout the country at the close of 1904, 9,894 savings banks, namely 7,883 postal and 2,011 private and municipal, an average of 111 depositors in postal, and 190 in private and municipal savings banks for every 1,000 inhabitants of France.

SALT IN TURK'S AND CAICOS ISLANDS.

These islands are almost entirely dependent upon the salt industry, and, owing to the abnormally wet seasons, 1905 aud 1906 were amongst the worst ever experienced in the history of the islands. The inability of the salt pond owners to meet the demand caused the purchasers at the principal markets to seek fresh sources of supply, especially in the Trapani district of Sicily, so that when at last abundant supply of salt was ready for shipment little or no demand for local salt at profitable prices existed. And the high protective duty, about 6 cents, or threepence per bushel, on foreign salt imported into the United States, makes it a matter of impossibility for the majority of salt pond owners to retrieve their losses. New districts in the United States, by the development of railways, are gradually being opened up for the utilisation of salt lakes and mines, and this increased production of domestic salt is confining, more and more, the use of imported salt to the packing factories situated in close proximity to the seaboard of the Atlantic. The Governor of Jamaica, in his report upon the islands (Cd. 3729-5), suggests that efforts to extend the trade with Canada might be successful, but united effort and enterprise are necessary, and neither, he says, is forthcoming to any large extent. In the Caicos Islands subsidiary industries supplement the production of salt, the most important being that of sisal fibre, but the exports do not increase. On the contrary there is some shrinkage, the value of the exports in 1899 amounting to £7,494, and last year only to £5,605. The export of sponge comes next in importance, amounting in value in 1906 to £2,418. The Caicos sponges are inferior to those exported from the Mediterranean, but they find ready sale at fairly remunerative prices.

ADMIRALTY CHARTS.

The following is the official list of charts issued by the Hydrographic Department of the Admiralty, in January and February, 1908:—

January.—New Charts.—No. 3683—England, east coast:—Meday river; approaches to Sheerness.

Charts that have received additions or corrections too large to be conveniently inserted by hand, and in most cases other than those referred to in the Admiralty Notices to Mariners:—

Index charts:—A. to V. No. 3346—Germany:—Jade and Weser rivers. 2842*a*—Baltic sea:—Western sheet. 2842*b*—Baltic sea:—Eastern sheet. 2826—Gulf of Finland:—Approaches to Viborg. 3479—Gulf of Finland:—Channels leading to Viborg. 2279—Gulf of Finland:—St. Petersburg bay. 2215—Gulf of Finland:—Kronstadt, north and south channels. 2239—Gulf of Finland:—The bay and city of St. Petersburg. 2059—North Atlantic ocean. 2058—North Atlantic route chart showing variation

curves. 2666—North America, east coast:—St. John's to Halifax. 2670—North America, east coast: Halifax to the Delaware. 2456—United States, east coast:—Nantucket sound and western approaches. 2892—United States, east coast:—Narragansett bay. 2479—United States, east coast: Black rock and Bridgeport harbours. 2471—United States, east coast:—New London harbour. 2857—United States, east coast:—Potomac river. 456—Jamaica:—Port Royal and Kingston harbour. 1098—Gulf of Mexico:—Lower Matacumbe cay to Boca Grande cay. 1499—Alaska:—Cross sound to Kadiak island. 3313—Alaska:—Yakutat bay; Controller bay. 1500—Alaska:—Kadiak island to Seguam island. 100*a*—Gulf of Aden:—Ras Galwéni to Ras Halún. 2722—Siam:—Koh kut to Bay island. 2725—Siam:—Koh Tron and channels leading to anchorages off Kamput. 1742—Canton river:—Sheet IV. 2400—China, east coast:—The bar and approaches to the river Min. 166—China, east coast:—Pagoda anchorage and approaches. 2847—China, north coast:—Hai yung tau, including Thornton haven. 1316—Korea:—Cape Dnroch to Linden point. 2432—Manchuria:—Tumen Ula to Strelok bay.

February. — New Charts.—No. 1836—Scotland, west coast:—Tobermory harbour. 3670—Mediterranean:—Malta channel. 3646—China, south coast, Canton river: Whampoa to Canton, sheet I. 3647—China, south coast, Canton river:—Whampoa to Canton, sheet II. 3605—China, south coast:—Hongkong to Mirs bay. 2543—New Zealand:—Maunganui bluff to Manukau harbour and Tutukaka harbour to Mayor island including Hauraki gulf.

New Plans and Plans added:—No. 1301—Plans on the coast of Chile. New plan:—Mejillones del Sur bay. 895—Eastern archipelago:—Plans of anchorages in Bali, Lombok, Sumbawa and adjacent islands: New plans:—Kombal bay, Ampenan road, Labuan Tring bay. 3002—China, east coast, Bias bay. Plan added:—Samun road.

Charts that have received additions or corrections too large to be conveniently inserted by hand, and in most cases other than those referred to in the Admiralty Notices to Mariners:—

1698—England, south coast:—Dover bay. 2447—England, south coast:—The Lizard and adjacent rocks. 125 — Belgium:—Ostende roads. 3377—Norway:—Ure to Brettesnes. 2483—Atlantic and Indian oceans. 2060*a* — North Atlantic ocean, eastern portion. 2202*a*—South Atlantic ocean, eastern portion. 2202*b*—South Atlantic ocean, western portion. 2564—United States, east coast:—Delaware river, sheet II. 2831—Gulf of Mexico: Galveston bay. 192—Gulf of Mexico:—Galveston entrance. 643—Africa, south coast:—Port Natal. 2908—Africa, south coast:—Port Natal entrance. 2762—Indian ocean islands:—Comoro islands, with adjacent coast of Madagascar. 3028—Cochin China:—Kam ranh bay.

These charts are issued by Mr. J. D. Potter, 145, Minories.

HOME INDUSTRIES.

The Hop Position.—Just before Parliament rose there was a discussion in the House of Commons upon the state of the hop industry in which several statements were made not easy to reconcile with official figures. It is common ground that the present position of the industry is deplorable, and the Americans are making what looks like a determined effort to capture the market. According to the Chancellor of the Exchequer the average prices for last season's hops run from 35s. to 42s. a hundredweight, while Sir Gilbert Parker stated in the debate that the latest importations have been offered at 25s. a hundredweight. However that may be, English hops of last season are being sold at prices which leave no profit, and there is no prospect of early and substantial improvement. The result must be further decrease in the area under hops, which last year was only 44,938 acres. The Chancellor of the Exchequer contended that the importation of foreign hops has had little to do with the present depression, and added, "there has been a steady decline in each decade in the quantity of hops imported from abroad." It would be more correct to say that until the present year there has been no appreciable increase. No imports have been less "steady." They have been in inverse ratio to the home production. For example, in 1903, when the total production of the United Kingdom was 421,068 cwts., the imports fell to 113,998 cwts. In 1904, when the home crop was only 282,330 cwts., the imports rose to 313,607 cwts. In 1905, when our own hop fields produced the largest yield on record, 695,943 cwts., the imports from abroad fell to 105,953 cwts. The Chancellor of the Exchequer went on to say, "There are two things which have really affected the hop trade. The first is machinery. We are producing the same quantity of hops out of a smaller acreage." Is that the case? The average yield per acre of hops last year was more than three cwts. in excess of the very low yield of 1906, but fell nearly half a cwt. short of the decennial average. Again, the Chancellor of the Exchequer attributes the fall in prices in considerable degree to "the use of hop substitutes." But according to the last annual brewing return nearly 64,000,000 lbs. of hops were consumed in brewing, against just over 29,500 lbs. of substitutes. It is much easier to demonstrate the deplorable condition of the home hop industry than to show how it is to be improved. Our variable climate is greatly against the hop cultivator. A week or two of wet, cold weather, at a particular period of growth, and the most promising crop may be irretrievably injured. Then the cost of production—at the lowest, £40 an acre—adds greatly to the risk. The profits are large, when weather and prices are good, but these are the rare years. It may well be doubted whether, without protection, the hop industry can long survive in the United Kingdom, and as the late Lord Salisbury told the hop growers of Kent, some years ago, the hop growers are not likely to get a tax on their particular

product unless they are willing to concede a tax on other people's products. It is, however, greatly to be hoped that some means will be found to induce a renewal of cultivation, which means so much, in certain districts, for the labourers.

The Shipbuilding Outlook.—The woodworkers and the engineers in the North of England have not yet consented to accept the lower wages insisted upon by employers, and the federation of shipbuilding *employés* have intimated that if the shipyard woodworkers will not come to terms with their employers before April 25th, a lock-out of all the shipyards in the federated area will be declared. This means practically a lock-out over the whole country, and apparently the only thing that can arrest it will be the consent of the strikers either to accept the reduced wages offered them, or to endow their executive officials with full powers to effect the best possible settlement with the employers. There seems to be little likelihood of the employers moving from their present position, so that it rests with the workmen to decide whether there is to be something like a national lock-out or not. The effects of the strike on the north-east coast were shown by the output in February, when only five vessels were launched on the Tyne, only one of these being a sizeable steamer. In the two months, January and Februaıy, only nine vessels were launched on the Tyne, as compared with twenty-two in the corresponding period of last year, and on the Wear only four vessels as compared with fourteen in the same period of 1907. In March the output was practically *nil*. Even on the Clyde the past quarter has been a very poor one, the actual output of the Clyde yards in the quarter being 60,080 tons, which compares with the 121,350 tons in the first quarter of 1907, and with 128,533 tons in the first quarter of 1906. We must go to the March quarter of 1895 for so small an output. Under these circumstances, it is not surprising to hear of the large and increasing number of the unemployed in many parts of the country, for the shipyards not only give employment to the artisans engaged in the actual work of structural erection, and to unskilled labourers, but also to the *employés* of a large number of dependent industries carried on outside the shipyards, such as chain and windlass making, rope making, sail making, electric fitting, copper and brass finishing, upholstering, and the various branches of engineering.

Values in the Country of Origin.—A well-known accountant, Mr. F. G. Wilson, has been commissioned by the Commonwealth Government to make enquiries in London, Manchester, and elsewhere with respect to the true European values of certain goods exported to Australia. Referring to this mission the *Melbourne Age* says that for a long time past a large number of cases have been accumulating in which it has been quite impossble for the local Customs experts to say whether the values in the country of origin submitted in the invoices relating to certain goods can be accepted as reliable or not. It may be that they are perfectly correct, but occasionally indirect evidence has been forthcoming that if investigation was pressed a little in the country of origin further light on the true value would be obtained. It is to make this investigation that Mr. Wilson has been retained by the Federal Government. He will enquire into at least twenty cases, carrying with them a detailed examination of books.

Cotton Profits.—In his latest Cotton Trade Circular, Mr. William Tattersall gives a summary of the accounts of six cotton companies which took stock for the quarter ended March 31st, and ten others which have just taken stock for the half year. The figures show an average profit of 24·67 per cent. per annum on the share capital, or 18·08 per cent. per annum on share and loan capital combined, after allowing interest on loans. On the other hand, Mr. Tattersall has compared the market quotations of the shares of about 100 companies in the middle of October last with the corresponding quotations on April 1st, and finds that there has been an aggregate depreciation of £670,000.

Insurance Enterprise.—The latest illustration of insurance enterprise is afforded by an insurance company recently established on non-tariff lines, which is now prepared to issue policies covering such liability as auditors may incur to their clients on account of errors committed by the clerks employed. The rates are moderate, and are understood to be based on the reputation in the past of individual firms and the number of clerks employed. Another department in insurance indemnifies chemists and druggists against loss in connection with claims arising out of errors in the dispensing and sale of drugs. Speaking of insurance, the final statement of losses incurred by the British insurance companies in connection with the conflagration at San Francisco in 1906, is given in the "Post Magazine Almanack" recently issued. They show the loss of the London Assurance Corporation to have been no less than £933,566; yet, notwithstanding this heavy set-back, its financial position is still very strong. Next in order of loss comes the Royal with £919,035, and the Liverpool and London and Globe with £800,713. These figures differ materially from those issued a year ago.

Coal and the Middleman.—Another attempt is about to be made to eliminate the middleman and bring the colliery proprietor into direct relations with the consumer. A coal mine near Mold, North Wales, has been purchased by a company for the purpose of supplying coal direct to consumers first at Birkenhead and later on at other places. It is estimated that the coal can be mined for 6s. 6d. a ton, railed to Birkenhead for about 1s. 6d., and distributed for 3s., whereas during the past winter coal has been selling in Birkenhead at 21s. per ton.

GENERAL NOTES.

STATE QUININE.—In Italy, the State sells quinine to the peasants in the malarious districts, and the profit is used to combat the malaria. Referring to the subject, Mr. Consul-General Neville-Rolfe (Cd. 3727-42) says that the methods employed in combating malaria are, first, the protection of the peasants from mosquitoes. This, owing to their ignorance, and their untidy habits, is a difficult matter, as they will not take care of the wire gauze which is placed over their doors and windows, nor will they adopt the precaution of using veils and gloves when they are obliged to go out at night. The second means used in the contest, is the draining of the land, and filling up the pools where the insects breed; and the third method, which is very effectual, is what is called "bonificamento," or improvement, which is affected by retrenching the land. adding the silt of rivers when available and thus causing it to absorb more moisture. Last year the State sold quinine to the peasants, of a value of £70,204, the net profit amounting to £18,515.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

APRIL 29.—"Modern Roumania." By ALFRED STEAD, Consul-General for Roumania. SIR PERCY SANDERSON, K.C.M.G., will preside.

MAY 6.—"The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE.

MAY 13.—"The Underground Water Supplies of the Thames Basin." By CLAYTON BEADLE.

MAY 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. MARTIN DUNCAN.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

APRIL 30.—"Reminiscences of Indian Life." By the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay. THE RIGHT HON. VISCOUNT MIDLETON will preside.

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

APPLIED ART SECTION.

Tuesday evenings, at 8 o'clock :—

APRIL 28.—"Lace as a Modern Industry." By Miss ISEMONGER. ALAN S. COLE, C.B., will preside.

MAY 26.—

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 27...Civil Engineers, 25, Great George-street, S.W., 8 p.m. (James Forrest Lecture.) Professor Henry Louis, "Some Unsolved Problems in Metal Mining."

Surveyors, 12, Great George-street, S.W., 4 p.m. Mr. Kenneth J. J. Mackenzie, "The Agricultural Education of the Land Surveyor."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. C. D. Fox, "The Southern Alps of New Zealand and their Glaciers."

TUESDAY, APRIL 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Miss Isemonger, "Lace as a Modern Industry."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. G Stoney, "The Development of the Modern Turbine and its Application." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

Photographic, 66, Russell-square, W.C., 8 p.m. 1. "The Carlograph Process by the Rotary Photo Company." 2. Mr. A. Gallenkomp Hartl's Method of Showing the Path of a Beam of Light through Optical Apparatus.

Zoological, 3, Hanover-square, W., 8½ p.m.

Horticultural, Vincent-square, Westminster, S.W., 3 p.m. Mr. E. White, "The Profession of Landscape Gardening."

Faraday Society, 82, Victoria-street, S.W., 8½ p.m.

WEDNESDAY, APRIL 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Alfred Stead, "Modern Roumania."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Dr. Francis Galton, "Suggestions for Improving the Literary Style of Scientific Memoirs."

British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

Dante Society, 54, Mount-street, W., 3½ p.m. Alfred Austin, P.L., "Dante's Poetic Conception of Woman."

THURSDAY, APRIL 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Lord Lamington, "Reminiscences of Indian Life."

Royal, Burlington-house, W., 4½ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. (Tyndale Lectures.) Mr. W. Bateson, "Mendelion Heredity." (Lecture I.)

Electrical Engineers, 25, Victoria-st., S.W., 8 p.m.

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m. Rev. H. J. Dukinfield Astley, "The Murailles Politiques of the Franco-German War (1870-71) and their Significance as Historical Sources."

Mathematical, 22, Albemarle-street, W., 5½ p.m.

Optical Society, 20, Hanover-square, W., 8 p.m. Dr. W. Ettles, "The Structure of the Eye."

FRIDAY, MAY 1...Royal Institution, Albemarle-street, W., 5 p.m. Annual Meeting. 9 p.m. Prof. J. Larmor, "The Scientific Work of Lord Kelvin."

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Paper on "Fresco."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Meeting to Consider and Compare the Design for the London County Hall.

SATURDAY, MAY 2..Educational Handwork Association (at the HOUSE OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.) 3 p.m. Prof. L. W. Lyde, "Temperate and Tropical Forests."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. G. F. Scott Elliott, "Chile and the Chilians." (Lecture I.)

Journal of the Royal Society of Arts

No. 2,893. VOL. LVI.

FRIDAY, MAY 1, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, MAY 6, 8 p.m. (Ordinary Meeting.) LOVELL N. REDDIE, "The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds."

Further details of the Society's meetings will be found at the end of this number.

APPLIED ART SECTION.

Tuesday evening, April 28; ALAN S. COLE, C.B., in the chair.

The paper read was "Lace as a Modern Industry," by MISS ISEMONGER.

The paper and discussion will be published in a future number of the *Journal.*

INDIAN SECTION.

Thursday afternoon, April 30; The RIGHT HON. VISCOUNT MIDLETON in the chair.

The paper read was "Reminiscences of Indian Life," by the RIGHT HON. LORD LAMINGTON, G.C.M.G., G.C.I.E., late Governor of Bombay.

The paper and discussion will be published in a future number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

NINETEENTH ORDINARY MEETING.

Wednesday, April 29, 1908; SIR PERCY SANDERSON, K.C.M.G., in the chair.

The following candidates were proposed for election as members of the Society :—

Azizuddin, Hussain, Khan Bahadur Mahammad, Collector and District Magistrate, South Canara, Madras, India.
Cunningham, P. A., R.I.M. Dockyard Extension, Bombay, India.
Din, Hon. Mian Mohd. Shah, B.A., Lahore, Punjab, India.
Goto, Baron S., President, South Manchurian Railway, Tokio, Japan.
Greaves-Walker, Arthur F., Utah Fire Clay Company, 1098 South First West-street, Salt Lake City, Utah, U.S.A.
Hart, Sidney George, Shillong, Assam, India.
Hughes, Hon. John, M.L.C., Vice-President of the Executive Council, Sydney, N.S.W., Australia.
Hughes, Right Hon. Thomas, Lord Mayor of Sydney, Sydney, N.S.W., Australia.
Kenyon, James, Walshaw Hall, Bury, Lancashire.
Larmour, Hon. Charles Frederick, care of Smith's Shipping Agency, 18, Eldon-street, E.C., and 60, Bentinck-street, Calcutta, India.
Parshad, Lala Joti, K.I.H., Jagadhari, District Ambala, Punjab, India.
Saklatvala, Shapurji D., 2, Norfolk-street, Strand, W.C.
Scotland, Thomas McIntosh, Tollcross, near Glasgow.
Shakespear, Lieut.-Col. John, C.I.E., D.S.O., 20, The Barons, St. Margaret's, Twickenham.
Slater, Edward Murray, Red House, Woodbridge, Suffolk.
Watkins, Arthur Anderson, A.M.Inst.C.E., Bala Lodge, Blackheath, S.E.

The following candidates were balloted for and duly elected members of the Society :—

Hood, James N., Fintragh, Midmills-road, Inverness.
Humphreys-Davies, George, 7, Portsea-place, Connaught-square, W.
Leeson, J. H., St. Thomas's School, Howrah, India.
Morrison, Captain James, K.I.H., Nagpur, Central Provinces, India.
Nicholson, Sir Frederick Augustus, K.C.I.E., Yercaud, Madras Presidency, India.
Parcon, Raymond, F.R.G.S., Victoria-Mahé, Seychelles.
Wills, Henry Tarleton, Morley's Hotel, Trafalgar-square, W.C.
Wilson, James, C.S.I., Lahore, Punjab, India.

The CHAIRMAN, in introducing the reader of the paper, said that the paper dealt with modern Roumania, a country which was scarcely so well known in England as it might be with advantage. It possessed not only that historical interest which attached to the connection of the country with the ancient Dacia and Mæsia and its inhabitants, with the Roman legions which fought under Trajan, but also that later and more prosaic, but very material, interest which lay in the opening up of the Danube to trade and commerce by the International Commission—a work in which a British engineer had played so large a part.

The paper read was—

MODERN ROUMANIA.

By ALFRED STEAD,
Consul-General for Roumania.

Although the subject of my paper to-night is "Modern Roumania," it is quite impossible to gain any real idea of the modern country without some knowledge of its past history, the foundations upon which the modern State, the State as we see it to-day, is founded, and from which have sprung those national forces which are still moulding and changing the destinies of the Roumanian race.

"For seven centuries," runs one of the declarations of the "Lieutenance Princière" to the National Assembly in 1866, "the Roumanians have struggled to become a powerful State, based on solid and liberal institutions; their struggles to this end have been heroic, and no history is richer than theirs in great deeds, in sacrifices, and in abnegation. . . . . Since the foundation of their fatherland, they have had to fight against many obstacles, against many ambitions, against numerous aspirations of conquest; they have had to struggle against those intrigues which sowed discord amongst them; they have had to fight against armed incursions; they have had to repel at the same time the influx of barbarians and the covetousness of many powerful neighbours; from all these struggles the Roumanians have emerged triumphant. Firm in their faith and in their desire, strong because of their origin and because of their valour, they have traversed all these vicissitudes."

Roumania is certainly not a State built upon the sand, a creation of yesterday, but she gathers strength and inspiration for the present from that time when, centuries ago, the Roumanian nation stood amongst the foremost of civilised States, and played a great *rôle* in the shaping of Europe. The history of Roumania has been one long series of struggles for the preservation of the autonomy and of the national character of those two former principalities of the Danube, Moldavia and Wallachia, which formed for centuries the rampart of Christianity and Occidental civilisation against the invasions of the Turks and of the Tartars. The Western nations of Europe owe indirectly a debt to Roumania, since they were enabled to work quietly in the development of their civilisation while Roumania, though reeling under the first shock of the Oriental advance, kept it at bay. It was in these conflicts and perils that the warrior blood of the legions of Trajan, the founders of the Roumanian people, proved that time had not sapped its vitality nor diminished its valour. For it must not be forgotten that Roumania was the scene of the exploits of the Emperor Trajan, the ruins of whose bridge over the Danube remain a signmark of the national heritage of the Roman settlement, and Roumania's early history stands chiselled in undying figures on the Trajan Column at Rome. Not only did Rome's warriors traverse and inhabit the country, but on the shores of the Black Sea, where now there flourishes the great seaport of Roumania, Constantza, Ovid lived in exile, surrounded by his admirers and friends. But after Rome the deluge, and in the following centuries of struggle, the Roumanian people, as Roumanians, found themselves. In these constant later wars there was apparent no decrease of valour, and it was the same spirit which led the Roumanian levies in 1877 to storm the lines and redoubts of Plevna, and created for the national heroes a wider fame. Such were Mircea Bassaraba, hospodar of Wallachia, who fought as an ally of Europe against the armies of Bajazide under the walls of Nicopolis towards the end of the fourteenth century; Nichei the Brave, who succeeded for some time in uniting all the Roumanian countries under one crown; and Etienne the Great, hospodar of Moldavia (1456-1504), who was not only a great soldier but also a great statesman. He stands as perhaps the most noble and distinguished figure ever produced by the Roumanian race. Pope Sixtus V. named Etienne "the Defender of Christianity," whom in recent years King Charles of Roumania rightly declared to be "great amongst the most great." These wars, these sufferings, tried and proved the race, and purged them as with fire—a needed preparation, if the nation was to survive the more dangerous ordeal of a debased political development. For this national force was sapped and corrupted with the advent of the rule of the Phanariot princes, until in 1850

two principalities, Moldavia and Wallachia, vegetated under the suzerainty of Turkey and of Russia. The transition of this estate to its present position has been the history of modern Roumania.

It may, perhaps, be permitted here to draw a parallel between Roumania, in her rapid development into a modern national force, and that other country, whose national progress has astonished the world and created a new world situation — Japan. There is a very curious similarity between the two countries. Both races are distinct, situated in the midst of totally different peoples; both countries were, until some few decades ago, feudal lands, and in both, agriculture ranked far higher than industry or commerce. In both countries the same great force has wrought the astonishing results now seen by the world; that same great force of natural patriotism, that divine fire without which no nation can hope to live, much less to become worthy.

Roumania may well be proud to be called the Japan of Europe—now a term of praise and highest honour. She has achieved, in the midst of the incessant jealousy and opposition of Europe, much that the free Empire of the Far East has accomplished. But, in all justice, it must be recorded that the progress of Roumania, if less great, is perhaps more meritorious even than that of Japan. To a small State, which was hampered at every turn by Turkish reaction and European greed or ignorance, with frontiers marching with great empires, the opportunities of progress were much less facile than in the island empire of Japan, comparatively free from outside influence. The Roumanians do not lack patriotism (their past history affords ample proof of that), and that patriotism it is which enabled them to hold fast to their position as the outpost of Europe in the Near East. But it was an unregulated and often undisciplined patriotism, sometimes even exploited against the aims of the country by outside Powers of indigenous aspirants. And it is, therefore, that we must count the beginnings of modern Roumania from the time when the Roumanians recognised their destiny, and determined to work it out under the guidance of a ruler of foreign blood. This determination was well expressed by the great patriot Bratianu, when he wrote:

"No obstacle will prevent us from reconstructing Roumania. It is now only a question of time and the road to be traversed, when it means to be or not to be! . . . No, henceforth nothing will arrest our rush. We have already secured a great victory. Europe has already recognised that we are a people destined to fight and to triumph through freedom. Our place is marked among the nations which constitute the Republic of Europe. It is for us to conquer it."

Of the national awakening a great Roumanian has said:

"Heavy indeed has been the labour of the resurrection of the Roumanian people. They, who for centuries had lain in chains were suddenly summoned to decide upon the foundation of their future. The people then expressed their wishes for the present with wisdom, for the future with foresight, and with good faith for both. The Roumanian people were determined upon the union of the principalities of Moldavia and Wallachia under the name of Roumania into one single State with constitutional institutions, and, in order that this determination might not have the character of a merely fugitive incident, but that it might remain an enduring influence, it was prescribed by the Declaration that the Roumanian Sovereign should be elected from amongst the members of an European Sovereign family, so that he might enjoy at home and abroad, the authority and prestige which befit the Sovereign Founder of a dynasty, and so unite Roumania by ties of blood to the great family of European States. Such was the demand, general and unalterable, imperious and absolute, of the Roumanian people."

When Prince Charles of Hohenzollern Sigmarien landed in Roumania on May 10, 1866, and, by the unanimous wish of the people, assumed the control of the Roumanian destinies, the new era of the country really began upon systematic lines. In the worde of the great Roumanian statesman, Demeter Sturdza, who was serving his country when the young prince arrived, and who to-day occupies the post of Prime Minister to the King:

"From that day the Roumanian people have laboured beneath the yoke of a gigantic undertaking, and our confidence in ourselves has firmly taken root. Since then a great change has taken place. Never for a single moment have we stood still, our progress has been steadfast and unceasing, for we had to accomplish every ten years the work of a century lost. Thus we have surmounted the greatest difficulties, and the renascence of the Roumanian people has been accomplished. This nation has entered upon the path of that constant labour which renews and consolidates a people's strength."

Where once was chaos, corruption, and the worst remains of the Phanariot rule, to-day is an orderly State, bound in friendly alliance with great Powers, and, more important still, an example to the world of peaceful internal development and a tranquil but persistent foreign policy, which seeks friendship every-

where, and is not overruled and endangered by a too fierce desire of change or aggrandisement, such as often characterises small States.

It is impossible to overestimate the value of the influence of King Charles upon this renascence of his country. Little by little, inspiring by his example, upholding by his buoyant confidence, he has systematised and strengthened the love of the Roumanians for Roumania, until to-day not even the evil, insidious dregs of Phanariotism or the harmful influences of foreign education can hope to prevail against the more healthy national spirit permeating the people over whom he rules. The national standpoint was outlined by King Charles when he said:—"By ourselves alone! These proud words, which ornament the Roumanian crown, deserve to be engraved within the heart of each Roumanian. They should be our guide, for they will give us power to conquer all difficulties, and will strengthen our faith in the future." And there are not wanting practical results of this policy, for in the Dobrudja, incorporated in Roumania after the war with Turkey, the king has created a great commercial port at Constantza, whence the grain and petroleum of Roumania can flood the market. From here will radiate a Roumanian marine, which will bear the Roumanian flag to all parts of the world. Agriculture has been carefully cherished; and to-day the country is one of the principal grain-exporting countries of the world. The lot of the peasant, formerly so low, has been improved, especially by the new agrarian reforms, which stand perhaps unique as a comprehensive effort to solve one of the most difficult of questions; and a compulsory educational system has been organised, owing much to the direct support and inspiration of the royal family. The finances of the country have been placed upon a stable footing, and although the nation has already acquired a sufficiency of debt, the future is not at all dangerously beset. Thanks to the discovery of extensive petroleum fields, Roumania has been strengthened and released from the position of a country relying solely on the rain and sun for its prosperity; while thanks to the King's indefatigable efforts and unceasing watchfulness, the petroleum industry has been protected from becoming the monopoly either of the ruthless Standard Oil Trust, or of other outside forces inimical to the welfare of the country.

Roumania to-day, with her 50,700 square miles (only a little less than the area of England) and her population of 7,000,000, is a constitutional monarchy in the best sense of the term, with all the rights and privileges of the Roumanian subjects amply guaranteed. The legislation, under the King, is vested in the elected Chamber. The Chamber of Deputies is composed of 183 members elected for four years, and the Upper House, or Senate, consists of 121 members, of whom all save 9 are elected. These nine are: the Crown Prince, when he attains the age of 18; the two Metropolitans, and six Bishops. Senators are elected for a period of eight years, half their number retiring every four years, and they are eligible for re-election.

There is absolute freedom of religion in Roumania, no discrimination being made against any sect. The national religion, however, is the Greek Orthodox, but the old influence of the Church suffered great diminution after the secularisation of Church property by Prince Cuza, who, in this respect, might be called the Henry VIII. of Roumania.

It is largely due to the excellence of her army that Roumania has been able to enjoy peace and development undisturbed by foreign aggressions. King Charles has ever been at heart a soldier; and his work in connection with the Roumanian army has proved not only his enthusiasm but his military ability. His work during the early years created a solid administrative foundation for the army, which was tested and found good in the fields before Plevna. There, in 1877, the young Roumanian army saved the Russians and gained their country's independence, and to-day, with some quarter of a million men on a war footing, the Roumanians are ready and able to play a decisive part in the history of Europe should their country and their king demand it. The *morale* of the troops is so good as to call forth the admiration of the foreign *attachés* who year by year attend the Roumanian manœuvres, and their arms and equipment, notably those of the artillery, are equal to those of any other country.

Roumania is a maritime State in so far as she possesses a considerable coast-line on the Black Sea, and for the protection of her interests in these waters there exists a small fleet of secondary war vessels—cruisers and torpedo-craft. Roumania also possesses in the Danube a waterway not only of great commercial importance, but forming her frontier with Russia, Hungary, Bulgaria and Servia. This great European stream is an international

highway, and should be subject to international supervision and control. Save, however, for the mouth of the Danube, which is under the jurisdiction of an International Commission, the river has been controlled either by individual Powers or entirely neglected. This International Commission for the Control of the Mouth of the Danube, by the way, which was constituted by the Treaty of Paris, stands, I believe, as perhaps the only instance of the European Concert working peacefully and constructively for some practical end. Indissolubly connected with the work of the Commission and the transformation of the Danube into a navigable waterway, is the name of the eminent engineer, Sir Charles Hartley, who is regarded in Roumania as the creator of the river of to-day, and is affectionately called the Father of the Danube. It is a great pleasure to me that in your Chairman to-night we have one the greatest authorities upon the work of the Danube Commission; and he must understand the appreciation of Roumanians for him and his Commission when he considers the creation of a special river fleet for the Danube, whereby Roumania has given the most satisfactory assurance that she takes very seriously to heart her duty of adequately policing the Lower Danube, that is to say, that part of the river which stretches between the jurisdiction of the International Commission and of Hungary. The systematic supervision and regulation of the Lower Danube has an international significance which cannot be ignored, since the success of this undertaking must inevitably affect the question of the control and supervision of the river above the iron gates. In other words, it may eventually mean the realisation of the true international idea of a free Danube. So adequate, indeed, is this river fleet for the maintainance of an efficient supervision of the Lower Danube, that, in the very unlikely event of the dissolution of the International Commission, its duties could be assumed by Roumania alone. With reason did King Charles exclaim, on the occasion of the christening of the fleet at Galatz:—"The war for our independence, making us, as it did, masters of the mouth of the Danube, gave to our navy a serious existence. We have, therefore, the duty of strengthening our naval forces, in order to be able to fulfil the high mission which has fallen to us on this great river." Besides its internal importance, the Roumanian fleet on the Danube is a notable development of the defensive force of the country. Indeed, no other European Power possesses such a powerful river flotilla. The fleet consists of four modern monitors and eight torpedo-boats, both types presenting several noteworthy points.

The financial prosperity of Roumania, although there appears to be, unfortunately, a tendency to ignore Roumanian finance in this country, is quite remarkable, and there are ample grounds for regarding the financial standing of the country as most satisfactory. It is true that Roumania has passed through financial crises, but that is not an experience to small States alone. Some six years ago the country underwent a crisis of this kind, but was saved by the inauguration of strict economy, the reduction of expenditure for a series of years, and the issue of budgets with surpluses, in order that these surpluses might be used for public works to the exclusion of all loans. Many reforms were instituted in the financial system, notably the abolition of the octroi, which has produced the best financial and economic results, and the institution of numerous popular banks, which have been enormously developed, and which are destined to play an important role in an early solution of the peasant question, creating as they do so much improvement in the economic conditions of the rural population, encouraging thrift, and furnishing them with an efficient protection against usury.

The National Debt of Roumania, both internal and external, amounts at the present moment to £56,000,000, which is equivalent to a sum of £8 per head of population (in the United Kingdom, in 1907, the National Debt amounted to £16 per head of population), but a very great proportion of this debt has been incurred for remunerative national undertakings, and is offset by realisable assets of greater value than at the time of the floating of the various loans. Another very satisfactory point is that all the loans issued by Roumania have been subscribed without any special guarantee, beyond the general guarantee of the State, being given. Roumania is thus a noteworthy exception to the majority of States; and the fact testifies to the confidence and credit that the conduct of her national and financial affairs has inspired in the markets of Europe. The first loan, amounting to £2,040,000, was issued by Roumania in 1868 at an interest of seven and a-half per cent., and was taken up by a syndi-

cate of bankers of Vienna and London with a term of 92 years. All subsequent loans issued by Roumania have been at five per cent., and nearly the total sum of these loans has been converted at different periods into four per cent , so that there remain only £7,400,000 at five per cent. The greater part of the Roumanian National Debt has been used for the purchase and construction of railways, which expenditure represents nearly £32,000,000. The State railways, besides being an asset of great intrinsic value, produce annually a net profit of more than £1,250,000, a revenue which is increasing every year. The rest of the Debt has been spent upon the construction of roads, ports, public buildings, military works, and other necessary national undertakings. Although Roumania has never had to offer any special guarantees, the National Debt is amply secured, not only by the flourishing condition of the Roumanian finances—which for the last seven years at least have produced an annual surplus averaging 11 per cent. of the revenue—but, at the same time, by the property owned by the State, the railways, the forests, the great oil-bearing lands, the fisheries, the immensely rich and practically inexhaustible salt mines, &c. It is, however, indisputable that the financial prosperity of Roumania is the most important point to be considered by creditors wishing to be assured of the security of their investments. This prosperity is demonstrated by the great development of the revenue and of trade. The Roumanian State revenues, which in 1875 amounted to £4,000,000, have now reached the sum of £16,400,000. In the last six financial years, there have been surpluses varying from £800,000 to £2,000,000; and it is by means of these surpluses that the public works in course of construction have been provided for. At the same time, the foreign trade of Roumania is extremely prosperous; and in all the normal years, that is to say, when there was at least an average harvest, the exports surpass the imports. Thus the total commerce of Roumania was, in 1906, £36,491,750, of which the imports represented £16,862,740, and the exports £19,654,404, which gave a balance in favour of Roumania of £2,791,664. In view of this prosperous financial condition, it is not surprising that Roumanian State Bonds should stand high. The Five per Cent. Bonds averaged 101, and the Four per Cent. from 89 to 94 during the last six months. Nearly all the Roumanian Loans have been made on the Continent, notably in Berlin, and British capital has practically ignored the Roumanian field, which, however, seems to offer such security and profit as are seldom to be found together. More especially is this indifference to be wondered at when it is remembered that there has existed in Roumania for years a prosperous English bank, the Bank of Roumania, which is in a position to advise and gather information of the most assured accuracy on any subject.

The revenue is composed of the sum obtained by direct and indirect taxation, monopolies, public services, State lands, and miscellaneous resources. The direct taxes consist of the following:—A poll-tax, a land tax, a tax on the spirit distilled from plums, a tax on patents, a tax on the shops for the sale of alcohol, a tax of three per cent. (formerly five per cent.) on the salaries of all public and private officials and on pensions, a tax on unearned incomes, and additional centimes on certain taxes for special objects. The chief indirect revenue proceeds from the Customs tariff, which is designed to protect the industrial growth of the country. There are five State monopolies in Roumania—for tobacco, salt, matches, playing-cards, powder, and cigarette-papers. The salt monopoly is the most ancient, and the right of working the salt deposits used formerly to be vested in the person of the Prince. Much of the salt produced is exported to the neighbouring countries. There exist no fewer than fifty known deposits of salt in Roumania, and it has been estimated that in the two principal mines there are still available 600,000,000 tons of salt of very pure quality. This monopoly yielded some £300,000 to the State in 1906. The tobacco monopoly yields one of the most important sums of the Budget, and its net revenue has risen from £500,000 in 1879, when the monopoly was created, to £1,600,000 in 1906. It is of interest to note that the French Tobacco Régie has recently put on sale Roumanian cigarettes in Paris with great success. The value of the cigarettes lies in the purity of the tobacco used in their manufacture. The monopolies of matches, playing-cards, powder and cigarette-paper yield relatively small amounts to the revenue.

The State lands were formerly of much greater importance, but they have been very largely cut up to supply the needs of the peasants under the various agrarian laws. At present they consist of 988,000 acres of arable lands and forests, but during the reign of King Charles alone, 3,000,000 acres of

State lands have been handed over, of which the majority was given to the peasants in small holdings. The purchasers of these small holdings were able thus to acquire land at low prices, and with the payments spread over a number of years. Mention must be made of the Royal domains, of which there are twelve, scattered about the country, since these, under the able direction of M. Kalindéro, have been converted into model estates for the instruction of the surrounding peasantry.

Closely allied to the working of the State lands is the development of the various rivers and stretches of water possessed by the State. In this direction, recent years have seen the creation of a large and flourishing fishing industry by the activity of Dr. Antipa. Roumania is one of the richest countries in fresh water of all Europe. More than 6 per cent. of the total area of the country is covered by rivers tributary to the Danube, or by the marshes found in the vicinity of this river, or by the immense lakes on the coast of the Black Sea, as well as by the smaller lakes of the interior. Thus Roumania possesses some of the most important fisheries in Europe, after those of the Volga. The fisheries of the Danube and of the coastal lakes are especially famous. The right of fishing in the waters of the Dobrudja and of the State domains belongs to the State. Formerly, this branch of the economic activity of the Roumanian people flourished greatly, and constituted one of the principal occupations of the nation; moreover, the culture of fish in artificial ponds was widespread; nearly all the landowners possessed such ponds when possible. Fish is to-day largely exported from Roumania to Galacia, Austria-Hungary, &c., and it is not usually known that Roumania is one of the largest producers and exporters of caviare. Up till ten years ago, fishing was practiced entirely without method. In most cases the ponds and lakes were farmed out to contractors, who exploited them without mercy. In 1896, a Fisheries Law was passed by the Roumanian Paliament, which introduced for the first time some regulations of the exploitation of the fisheries. Beyond these measures, the law provides for the establishment of protected regions, where fishing is prohibited during the whole year. This law does not permit rubbish from the factories, &c., which is liable to harm the fish, to be thrown into the water. With regard to the Danube, and the Pruth, the measures inaugurated by Roumania have been adopted by the adjacent countries—Russia, Bulgaria, Servia, and Hungary. In these fishery conventions may be found the basis of future concerted action by the riverain States with regard to the Lower Dannbe, since one common interest often brings to light others.

Roumania possesses in the valley of the Danube alone 2,250,000 acres of inundated land, and including the other rivers of the country 2,400,000 acres, or 8 per cent. of the total area of the country. In 1906 a law was passed and funds of 3,000,000 francs were provided in order to proceed with the drainage of the inundated lands. This work has already been commenced on State property extending over about 7,000 acres. In connection with these inundated lands there is every prospect of its being possible to create an industry of rice-growing, similar to that now existing in the southern portions of the United States.

The total length of railway lines in Roumania is 2,000 miles, or 24 miles of line per 1,000 square miles of area. This gives about 3,000 inhabitants per mile of line. The first line was constructed in 1867, after the accession of King Charles, by an English company. Owing to the restricted financial resources available in the early days, the Government had to depend for the construction of the lines upon foreign contractors, or more often secure construction by the granting of concessions, with a guarantee from the State of a minimum net dividend. Two companies built 710 miles of line between 1867 and 1875, under these conditions, the State guaranteeing a dividend of seven and a half per cent. on the capital invested. In 1880, the State bought out one of the companies, floating a special loan of £9,500,000 at six per cent. Two years later another line was purchased, and in 1888 the last private company was taken over, on the basis of an understanding with the shareholders. In 1890, the Roumanian State undertook the construction of necessary railroads itself, and in fifteen years built 1,125 miles of lines. The superiority of State construction over the former methods has been amply demonstrated; not only does it afford employment to Roumanians, but it represents a saving which averages £600 per mile. Lines constructed by the State only cost on an average £9,600 per mile, against an average cost of £10,200 for foreign construction. The total capital spent on railways for purchase and construction amounts to the actual sum of £30,932,600. For the year

1905-6 the receipts amounted to £2,800,000, and the expenditure to £1,480,000, making a surplus of £1,320,000. This is all the more remarkable since the population of Roumania is almost entirely agricultural, travelling little, and not possessing the available funds for railway journeys. In no country is it the agricultural population which produces the greatest proportion of railway receipts, and as the petroleum and other industries develop, the railways cannot fail to earn a still greater revenue for the Roumanian State. It is in the State control of the railways that Roumania largely owes her ability to resist all the attempts made by the Standard Oil Trust to monopolise the production of petroleum in the country. An interesting detail is that, in order to obtain a greater and more rapid extension of the railway system, the State has authorised by special law the construction, under certain conditions, by local authorities and private individual of secondary lines of local interest. This in no way interferes with the State reservation of the right to construct and work all future lines of national importance. State ownership of the railways has not produced any tendency to increase the fares unduly; the first-class fare per mile per person is 1½d. up to thirty miles; the second-class fare is 1d. per mile up to fifteen miles, and the third-class fare is ¾d. up to ten miles. Special reductions are made for longer distances, thus, for a dis- of 400 miles the fares charged are as follows: First-class, 1d.; second-class less than ¾d., and third-class less than ¼d.

The Roumanian system joins those of neighbouring States at six points, five of which connect with Austro-Hungarian lines, and one with Russian. Towards the south, the lines are not yet directly joined to those of Servia and Bulgaria, it being necessary to cross the Danube by boat. The most important line is that running to Constantza on the Black Sea, since this port is the one Roumanian outlet open to navigation all the year (the Danube ports being frozen in for some three months). This line crosses the Danube by the great bridge of Cernavoda, the second largest in continental Europe. This magnificent bridge is a triumph for Roumanian, having been built according to the plans of M. Saligny and under the direction of Roumanian engineers. The main section of this bridge over the principal branch of the Danube is 750 metres long and 30 metres above the water-level. Besides the actual bridge, there were necessary viaducts of over three kilometres in length, the whole work costing over £1,400,000. The port of Constantza, which is rapidly approaching completion, is also worthy of mention. It is situated on the Black Sea, at the Eastern extremity of the great railway system of Central Europe, and is, by virtue of its position, a natural centre for the distribution of the produce of the Near East. For ten years the Roumanian Government has spared no expense in the construction of the docks and harbour, which are already open to vessels of the heaviest tonnage, and which form the chief outlet for Roumania's immense and ever-increasing production of petroleum. The port is provided with the most modern appliances for the storage and shipment of petroleum, and the gigantic oil-reservoirs are among the largest in the world. Constantza is served by regular lines of Roumanian Government passenger and cargo steamships, sailing to Constantinople, Smyrna, Alexandria, Rotterdam, &c., and may be regarded as one of the most important seaports in the Near East.

Together with the advance of national prosperity, the statistics of the postal movement, sure indication of civilisation, show a remarkable increase of late years. In 1904 there were only 29,000,000 postal packets, while in 1906 the number had amounted to 194,000,000, or 550 per cent. in three years. By a co-operation with the *employés* of the State monopolies, the Roumanian postal authorities are able to maintain a regular service of letter delivery several times a week to the most remote villages. In 1904, Roumania was fourteenth among the twenty European States, as regards letters per head of the population, while in 1906 she had reached the twelfth place, with 33 letters per head. Roumania had out-distanced Italy with 27 letters per head, Spain with 18, Hungary with 18, Bulgaria with 9, Russia with 7, and Turkey with 1.

In Roumania, as in Japan, the people have constantly held to the old Japanese adage, "Agriculture is the nursing mother of the State;" and agriculture has always constituted the principal source of wealth in Roumania. The fertility of the vast Roumanian plains has enormously facilitated the development of agriculture in that country. The climatic conditions, also, permit the cultivation of the most varied plants. The rye and barley of the North are met with here side with the maize and tobacco of the warmer countries. About 40 per cent. of the extent of Roumania consists of arable land, and of this nine-tenths is devoted to the

production of cereals, wheat and maize being especially important. The average production of corn has been, during the last five years, 74,000,000 of bushels per annum. This production reached in 1906 the very considerable figure of 110,000,000 of bushels. The quality of the corn grown in Roumania is of the best. Corn giving a weight of more than 64 pounds per bushel is frequently met with in Roumania, and chemical analysis has shown that Roumanian corn is one of the richest to be found in Europe in the proportion of gluten.

Another source of national wealth in the future will be found in the development of the pastoral, and notably of the dairying industry, which is immediately profitable for the enrichment of the small proprietor. Roumania may well look forward to the day when she will occupy in this industry the same position to southern and south-eastern Europe as Denmark does to the northern and north-western countries.

But it must ever be difficult to build up a flourishing and great State with only agriculture as a foundation. And thus the development of the great petroleum resources of Roumania are of paramonnt national importance, for the most valuable and important of the mineral resources of Roumania is petroleum. The petroleum zone extends to the foot of the Carpathians, with a length of nearly 350 miles and a width of about twelve miles. The total area of the Roumanian petroleum fields is thus computed to be about 1,800,000 acres. According to the exploitation carried out up to the present, it is estimated that one acre of oil-bearing land has produced an average output of 10,000 tons. Assuming the extent of the oil-bearing land to be, at the lowest computation, 600,000 acres only, and the output per acre on an average only 6,500 tons, the petroleum resources of Roumania amount to no less than 4,000 million tons, which, at a net price of 12s. per ton, represents a value of £2,400,000,000. During the last forty years, the exploitation has hardly reached 10,000,000 tons, so that the supply will be seen to be practically inexhaustible. The greatest annual output was that of 1,129,097 tons in 1907. There are to-day nearly £10,000,000 sterling invested in the Roumanian petroleum industry, the exploitation of which is carried on by means of the most modern and perfected mechanical appliances. The petroleum intended for export is taken to Constantza, where it awaits shipment in immense reservoirs, from which it is subsequently carried by steamer to every part of the world. In view of the growing substitution of petroleum fuel for coal on board many ships of the British navy, it is interesting to note that the port of Constantza is situated within easy distance of several British coaling stations. The great American Trust, the Standard Oil Company, recognised at an early date the importance of the Roumanian oil-fields, and has accordingly made several attempts to acquire control of the petroleum production; but the vigilance of the veteran statesman, M. Sturdza, has constantly baffled all efforts in this direction. In November, 1900, the contract was quite ready for signature, in virtue of which, in exchange for an advance of 10 millions of francs, the petroleum wells belonging to the Roumanian State were to be ceded to a syndicate, whose principal agent was the Standard Oil Company. This contract was to grant to the syndicate, in addition, the exclusive right of laying down pipe-lines for the transport of petroleum to the Danube and to the sea, as well as various privileges of railway transport, including the right of interfering in the drawing up of the railway rates. Had this contract been executed, the petroleum wells belonging to the State would have been irrevocably alienated; the yoke of Mr. Rockefeller would have been imposed upon all exploitation of petroleum in Roumania, and the American Trust would have acquired a new and solid base from which to crush all European competition. To establish a monopoly of petroleum in Roumania, it would be necessary to control the means of transport, as in America, where the Standard Oil Trust is master of a great part of the railways. In Roumania, however, the railways are the property of the State, and the Government has declared that, should the necessity arise for the construction of a pipe-line from the oil-fields to Constantza, this line would always belong to the State, so that the great artery of the Roumanian petroleum industry can never become a means of exploitation for the benefit of any Trust or monopoly.

The continued development of the oil resources of Roumania led to the Standard Oil Trust, through the intermediary of the Americano-Romanâ Company, to endeavour recently to secure control of the refineries of the country. Once the refineries of the country passed into the hands of the Trust, the position of the producers would be indefensible

against the monopoly, and, although a pipe-line monopoly would still be beyond the reach of the Trust, much of the value of the State control of the railways would be lost. The Roumanian Government decided to intervene, and flung down the gage of battle to the Trust in a law regulating the distribution of the raw oil amongst the refineries of the country—a measure drastic and comprehensive in the extreme, but well calculated to save the refining industry from monopoly. It is noteworthy to remark that this law was recently voted by the Lower House unanimously, and by the Senate by a very large majority. It may thus be taken to represent the views of all political parties. And it is interesting to note that the Roumanian Government, in the treaty recently concluded with the United States, reserves to itself complete liberty of action with regard to the industry and commerce of petroleum. The check given to the powerful Trust by Roumania in this law marks the commencement of a new era in the history of the petroleum industry, and may well have far-reaching effects upon the oil markets and prices of Europe.

Until twenty years ago, Roumanian industries were still in their infancy. In 1887, there existed in the country only one cloth manufactory, one metal-working factory, and two sugar factories. These latter enjoyed special facilities in virtue of a law whereby the State granted a bounty of 16 francs per 100 kilogrammes of sugar manufactured. Yet it was not until 1887 that the foundations of Roumanian industry were established by the passing of a law for the encouragement of national industry. By this law, every industrial establishment possessing a fixed minimum capital of 50,000 francs, a perfected plant, and a minimum namber of twenty-five workpeople could obtain from the State—

(*a*.) A free grant of land, not exceeding five hectares ;

(*b*.) Exemption from all taxes due to the State, the District, or the Commune ;

(*c*.) Exemption from Customs duty on :—1. Machinery and apparatus necessary for the installation of the factory. 2. Raw material not obtainable in the country.

(*d*.) Forty-five per cent. reduction in railway rates for manufactured produce, and 30 per cent. for raw material consigned to the factory.

These facilities were not granted to breweries, flour-mills, and distilleries, which could easily and cheaply obtain their raw material in the country.

In order to secure a larger development of the textile industries by the establishment of spinning-mills for flax and hemp, and, at the same time to encourage the cultivation of these plants in Roumania, a law passed in 1906 secured certain advantages to hemp and flax mills, granting exemption from Customs duty to fixed quantities of hemp and flax imported into Roumania, which quantities were to be diminished year by year. By this means it is hoped that the mills will cease in a short time all importation of foreign raw material. Equally profitable for the national industries will be the recently passed Patent Law, one of whose clauses provides that a patent shall cease to be valid if not exploited in a practical and effective manner within four years. Besides these different laws framed for the protection and assistance of the national industries, the Customs tariff is designed with a view to their effective furtherance. Thanks to these encouraging measures, Roumania has been able to lay the foundations of an important industrial activity ; and there are to-day about 500 factories in different parts of the country, with a capital of nearly £16,000,000 sterling.

Roumania enjoys the advantage of cheap motive power in the numerous watercourses falling from the Carpathians ; and the inestimable advantage of her abundant supply of petroleum, which furnishes an enormous quantity of residue, forming a cheap and excellent combustible.

In all his work of creating modern Roumania, King Charles has been aided by Her Majesty the Queen, so well-known throughout the world by her pen-name of "Carmen Sylva." By his marriage to Princess Elizabeth of Wied, "a marriage so non-political as to make it a political event of the first importance," the King brought to Roumania a Queen who made herself beloved of all, and who speedily became the centre of all charitable ideas and works. Her scheme for the foundation of a colony of blind workers, a colony which, once placed upon a stable footing, is to be completely self-supporting, intends, on the one hand, to ensure that all the blind people and their families in the kingdom shall be properly cared for, and, on the other hand, to produce citizens useful to the State who, under former conditions, would have been a tax upon it. Without the least distinction of religion or race, the blind are to be received into the colony, where they will be cared for and instructed in some useful profession or trade. To this colony will flock the blind from all the world,

since no blind person who is otherwise mentally and physically healthy may be refused admittance into the colony, which is organised upon the most practical lines, so that it will not share the disadvantage of so many purely philanthropic institutions of being unpractical in its administration. The colony, peopled entirely by the blind, will remove from these unfortunate people all sense of difference and disadvantage.

In the person of the Crown Prince, the nephew of the King, Roumania possesses a guarantee for the continuance of the great ideals and traditions of the present reign. For this country a special interest lies in the fact that the beautiful and gifted Crown Princess of Roumania is an English princess, niece to King Edward, and daughter of the late Duke of Edinburgh. This constitutes a close tie between the two countries, and should be a sufficient reason in itself for English interest and friendship.

Prominent amongst those Roumanians whose names will always remain indissolubly connected with that of their Sovereign in the regeneration of Roumania are the following: Jean Bratianu and Lascar Catargi, who played perhaps the most important rôle as collaborators with King Charles in the accomplishment of his great mission, Bratianu especially, as Prime Minister from 1876 to 1888, taking part in all the greatest events of modern Roumanian history—the War of Independence, the Declaration of the Kingdom, and the internal reorganisation of the State. Kogalniceanu, who had been the originator of the Agricultural Law under Prince Cuza, also played a great rôle, especially as Minister for Foreign Affairs, defending with eloquence and dignity the rights of Roumania at the Congress of Berlin; Jean Ghica, who represented King Charles at the Court of St. James's for ten years, stands prominent among Roumanian diplomats; General Haralambie, who, by his untiring efforts in the Lieutenance Princière, steered the young State through its early difficulties. Besides these, Maurojeni, who first reorganised the Roumanian finances; Alexander Lahovary, the energetic defender of the rights of Roumania on the Danube; C. A. Rosetti, and many others, have earned that imperishable monument to be found in the gratitude of their fellow-citizens.

Of all the great men who have devoted their lives to Roumania, only one remains who saw the awakening, and who is now perfecting the results of that awakening. M. Demeter Sturdza, the present Prime Minister of Roumania, stands alone as the pre-eminent statesman and patriot of his country. From the early age of 20, his life-work has been closely associated with the government of his country. Working side by side with the great men who are no longer living, M. Sturdza has had much to do with all those great works associated more especially with the names of others, besides those patriotic and political achievements which are peculiarly his own. He it is to whom in moments of crisis the entire Roumanian nation turns instinctively, confident that he can meet any danger—that he can save any situation, however impossible it may appear, and whatever may be the attendant dangers. In 1900, M. Sturdza saved the country from bankruptcy, and set its finances upon a footing which has assured permanent stability and national prosperity ever since. Only last year, on the occasion of the peasant disturbances, M. Sturdza, at the age of 74, took over the reins of Government, and, by a statesmanlike *tour de force*, succeeded in introducing and passing a series of agrarian laws perhaps unique in the annals of agrarian legislation. Roumania has owed much to his wisdom and prudence, and to his remarkable international position; and she is indeed fortunate to possess at the head of affairs one who is undoubtedly the most experienced of European statesmen.

Time will not permit me to mention many other sides of life in modern Roumania—the remarkable development of peasant industries under the guidance of patriotic women, who are determined that the wonderful national embroideries and pottery shall not disappear; the literary and artistic interests; the unique system of State and private hospitals; the wonderful scenery of the Carpathians, which will one day make Roumania the playground of Europe; the health-giving mineral springs, and the possibilities of sport in the forests after bear and wild boar; the large cities and the civic activity—all these are things to be seen for oneself. But all these details, even those sides of national life to which I have alluded at greater length, are but the manifestations of the working of the Roumanian national spirit; the patriotic determination of a whole people to work out their own salvation, and, looking backwards on their great past, to achieve a still greater future. The faces of the Roumanians are turned towards their national

ideals; and with Jean Bratianu they believe that "their place is marked amongst the nations which constitute the Republic of Europe. It is for them to conquer it!" First among small States, Roumania shall show to the world that there is no question of area governing the value of a national example, and that, though Roumania may always remain a small political State, she shall ever be a great moral factor, a force for progress which can never be overlooked.

DISCUSSION.

The CHAIRMAN (Sir Percy Sanderson, K.C.M.G.), in opening the discussion, said as the International Commission of the Danube had been referred to, it might be of interest if he very briefly traced its history. Prior to the Crimean war, Russia had gradually acquired control of the mouths of the Danube, of which it might be said that, although 63 per cent. of the whole water of the Danube passed out to the Black Sea by the northern, or Kilia, branch, and 30 per cent. by the southern, or St. George's, branch, the mouths of these branches were so obstructed by shoals that it was only the centre, or Sulina branch, with no more than 7 per cent. of the water of the main river. which afforded a navigable channel. In 1856, at the end of the Crimean war, Russia consented to the rectification of her frontier, and by the Treaty of Paris provision was made for the freedom of the navigation of the Danube, and for the formation of an International Commission, on which all the great Powers, namely, Great Britain, Austria, France, Russia, Sardinia, and Turkey, should be represented each by a delegate. The work of the Commission was to design and carry out the works below Isaaktcha, which might be found necessary to put that part of the river and the sea in the best possible state for navigation, and to settle the dues to be levied to defray the expenses connected with those works. A period of two years was allowed for that purpose, and in the meantime delegates from the Riparian States were to meet and draw up regulations for a Riverain Commission, to whom the works would be handed over by the International Commission, and these regulations were to be submitted to the Conference of the Powers sitting in Paris. But the task of the International Commission was a much more serious one than had been anticipated, and the work was very far from being completed at the end of two years; neither had the regulatious submitted by the Riverain Commission met with the approval of the Conference at Paris. The result was that the International Commission continued its work without any absolute treaty provisions from 1858 to 1866, when the matter was brought before the Conference at Paris, and an extension of five years, to 1871, was agreed upon. The work was carried on under great financial difficulty, and when the matter was again considered in 1871, it had been found necessary to raise a loan, and a further prolongation till April, 1883, was agreed upon in order to give time to pay it off. In the meantime, war had broken out between Russia and Turkey, and by the Treaty of Berlin of 1878, Roumania acquired her independence, and the right to representation on the Danube Commission, the whole of the Sulina branch proper being in her territory. In 1883, the powers of the European Commission were prolonged for a period of twenty-one years, with future prolongation for periods of three years, unless one of the contracting Powers gave notice one year beforehand of a desire to propose modifications. The Commission exercised its powers in complete independence of the territorial authorities, and it might be conceived that such a position might be very galling to any nation, but more especially to one which had newly acquired its independence. The advantage, however, to be derived in international co-operation in a work of that kind had not been lost sight of by Roumanian statesmen, and the Internationl Commission of the Danube had had no firmer supporter than the King and his present Prime Minister, M. Demexter Sturdza. As to the work which it had carried out, the result was summarised as follows in the words of Sir Henry Trotter's report of last year:—"The minimum depth of water over what was once the Sulina bar now stands at 24 feet instead of 9 feet, and the depth in the Sulina arm has a minimum of 20 feet instead of 8 feet. All sharp bends and circuitous curves have been eliminated, and the river itself had been shortened by 11 miles." The credit for the engineering work was due to Sir Charles Hartley, who was appointed Engineer-in-Chief in 1856, and retained that post till 1871, when he became consulting engineer, an appointment he relinquished only a short time ago after upwards of 50 years, during the last 36 of which he was ably assisted by Mr. Kuhl. It was Sir Charles Hartley who devised the method of increasing the depth by narrowing the channel, a system which was later adopted by Captain Eads at the mouth of the Mississippi with the best results. The effect in the Danube had been that, while in 1856 vessels of 250 and 300 tons could scarcely enter the river, vessels up to and over 3,500 tons were now trading with the Danube. But while the International Commission of the Danube hed contributed in a large measure to the development of Roumanian trade, the main strength of the country lay in the people themselves, in their tenacity on the one hand, and their desire to attain to the highest advancement on the other. As an evidence of tenacity, they could point to the fact that, notwithstanding the country was swept from time to time by hordes of barbarians, and that as finally settled they found themselves a Latin race wedged in, as it were, amongst Slav nations, they had always retained their language, of which the late Bishop of Southwell, Dr. Ridding,

once said that, in his opinion, it contained more pure Latin than the Italian of the present day. Great as had been the improvement in the River Danube under the auspices of the International Commission, it was no exaggeration to say that it was no greater than the advancement of the whole country under the guidance of the King and Queen, and of the eminent statesmen whose names had been mentioned. The contrast between what it was in 1876, when he first went there, and in 1894, when he left, was most remarkable, and the rate of progress did not seem to have diminished since.

Lord FITZMAURICE assured the audience that he had not attended for the purpose of making a speech, because naturally in the position he held he had to be a little careful about appearing to plunge into the domestic affairs of other countries. He was sure the audience would allow him, in the first place, to express the feeling of gratitude all felt to the author for the very clear and lucid manner in which he had brought forward the subject. Those who had travelled in Roumania would agree that his remarks recalled in a most lifelike manner the recollections of their travels, while he was sure those who had not had advantage of travelling in Roumania would take an the early opportunity of doing so. Like the Chairman, he had had an official connection, though a far smaller and shorter one, with the Danube, because his signature was that of one of the plenipotentairies who signed the last Treaty which governed the river. The work of the diplomatist, however, was very small compared with that of the engineer, and the trade and commerce of Europe, and of Roumania in particular, owed a debt of gratitude to that illustrious engineer, Sir Charles Hartley, for his work. The triumph of the engineer over accumulated difficulties, partly caused by Nature and partly by the folly of man, in obstructing the navigation of the mouths of the Danube was one of the greatest engineering triumphs the world knew. Sir Charles Hartley's name was for ever associated with that work. Every word also which the author had said about the magnitude of the work in spanning the Danube, at Cernavoda, was abundantly justified by the fact. When he first travelled in those parts, in 1871, so far as he remembered there was no bridge over the Danube, with the exception of the railway bridge at Belgrade, and even now there was a very great deficiency of bridge accommodation on the Danube. Those who took an interest in foreign affairs would have observed that, especially during the last few weeks, there had been a great deal of discussion in the European and English Press with reference to railway schemes in the Balkan Peninsular, every one of which more or less turned upon the possibilities of bridging the Danube further than it was bridged at present. For instance, the author had pointed out that one of the most important Roumanian railways touched the Danube roughly speaking at the town of Orsova, but there was no bridge there; and if ever the projected line of railway was made to join the Danube and the Adriatic, a vital and integral part of the scheme must be to bridge the Danube at or near the point he had indicated.

Dr. GASTER drew attention to the other side of the picture, and said that the National Debt was no less than 1400,000,000 francs, and the moneys raised abroad had been utilised for buildings, and for other purposes, which had not increased the true prosperity of the nation. There was nowhere a peasantry in the world so poor and wretched as the Roumanian peasant. There were no less than 80 per cent. of illiterates in the country, and they were almost without any political rights. The Roumanian peasant was highly gifted, and if properly educated, would work out his salvation, and raise Roumania to the highest position.

Sir HENRY TROTTER, G.C.V.O., K.C.M.G., said that the Chairman served in Roumania from 1878 to 1894, and he (Sir Henry) served in that country from 1894 up to last year, so that between them they had seen a good deal of Roumania. He knew the King very intimately, and had the greatest possible respect for him. When he first came to the country he was quite a young man and had to encounter great difficulties, which he had overcome by his personal abilities. It was a curious thing that M. Sturdza, for whom he also had the greatest possible respect, was at one time engaged in a conspiracy to remove the King from the country, as were also other high officials. The Prime Minister was a man of great capacity and one of the hardest working men he had ever met; he was short in stature, but he was head and shoulders above his fellow countrymen in administrative ability.

Mr. LEON GASTER said his impression was that the paper was merely a statistical report, compiled from official documents and gave only one side of the question.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Stead for his interesting and instructive paper.

Mr. STEAD, in reply, after referring to the remarks of Dr. and Mr. Leon Gaster, acknowledged the cordial way in which the vote had been received, and, like Lord Fitzmaurice, he invited the members of the audience to pay a visit to Roumania and to see for themselves the conditions which obtained there, because there was no information like first hand information, and the Roumanians would be only too glad to welcome English visitors.

The meeting then terminated.

THE TURKISH OLIVE INDUSTRY.

The olive tree grows wild, in great abundance, on many of the hills and mountains in the Aleppo vilayet, or province, and especially between Alexandretta and Antioch. Orchards are planted and grow well, chiefly in the environs of the cities of Antioch, Harem, Armenay, Salkin, Kossier, Kellis, Kurd-Dagh, Aleppo, Urfa, and Nazib. The olive does not require a rich soil, as is evidenced by the fact that, during the last twelve or fifteen years especially, large orchards have been planted in almost barren fields, unfit for the culture of cereals. The American Consul at Alexandretta says that at present there is a rather slow but gradual increase in the establishment of olive orchards throughout that district. The months of March and November are said to be the best in which to set out the trees. When an olive tree becomes old, a knot grows on the trunk just above the ground, having "eyes" similar to those on a potato. These knots are carefully removed, usually from wild trees, and placed or planted, with the eyes up, in pits ten or twelve yards apart, twenty-eight to thirty inches deep, and having a diameter of sixteen or eighteen inches. Usually a little manure is put around them when they are covered over with dirt leaving an opening, two or three inches wide, leading down nearly to the knot, so the shoots will grow up through, also to permit the rain water to run in. Unless it rains sufficiently, within a week or so, to moisten the ground, they are moistened weekly until the rains come Another method is to transplant small wild trees, also portions of the root of old trees having sprouts, in both cases observing the same rules as previously mentioned. Frequently the new plants fail to show much sign of life until the second year. In the spring of the first or second year, depending upon the rapidity of the growth, if the original was not of good quality, the most promising sprout is grafted, and the balance is cut away. The olive tree requires about seven years growth before beginning to bear profitably. It is never irrigated, receiving no water, except from the winter and spring rains. In some parts of Syria, grape vines are planted between the trees, when first set out, and are removed after the trees begin to bear well. The ground is cultivated by being frequently ploughed, but no fertiliser is ever used. The pruning is done by cutting away the dried and poor boughs not susceptible of bearing, the shape of the tree never being a matter of consideration. The length of life of the olive tree depends to a certain extent upon the care that it receives, but it is very hardy, and it is claimed that when properly cultivated and cared for it will live for centuries. As to the regularity of crops one year with another, there is no absolute rule. For three successive years the yield may be heavy, but it frequently occurs that a good crop is followed by a poor one. At times short crops are caused by frosts coming in March and April, when the trees are in bloom. Continuous cold weather during the winter season has a tendency to dry up the tree, and during the month of August, when the heat happens to be excessive, the fruit dries up and falls off. It follows, therefore, that a temperate climate is the most suitable for the cultivation of the olive tree. The fruit is gathered during the latter part of November, by lightly beating the boughs of the trees with a stick, which must be flexible in order not to injure the trees, and usually a large blanket is held underneath to prevent the fruit from being bruised on the ground. There are no official statistics whatever from which any idea can be gained of the number of acres of olive orchards or the number of trees. Very unreliable statistics give the amount of oil produced in the vilayet of Aleppo, during a good year, at about 19 000,000 lbs., valued at about £293,000. The market price at Aleppo regulates the price throughout the vilayet. The total amount of oil produced may be divided into two parts, about equal in quantity and value, the one for culinary purposes and the other for soap manufacturing. In good years the output of oil is about 25 per cent. of the quantity of olives used, but in bad years only about 12½ per cent. The method of pressing the oil from the olives is very primitive, and it is doubtful if there is a modern press in all the vilayet. The best quality of oil is produced in Killis and vicinity, where, it is stated, there grows as fine a quality or variety of the olive tree as is produced anywhere; and with a modern pressing and refining process, as excellent a grade of oil as that of Lucca could, it is said, probably be obtained. The quantity of green olives pickled is insignificant, and limited to a small proportion that is prepared for certain families, for their own use, and for the local trade. After the oil is extracted from the olives the pulp is sold to soap manufacturers for fuel purposes. The workmen employed in gathering the crop are paid in kind. When a proprietor has finished gathering his olives, he estimates the number of days the men have worked, and according to the importance of the yield, every four or six days' work is paid for with a box (about 44 pounds) of olives. When labourers are paid in money they are compensated at the rate of about 4½d. to 8d. per day.

RENTS AND HOUSING.

The report lately presented of an inquiry by the Board of Trade into working-class rents, housing, and retail prices, together with the standard rate of wages prevailing in certain occupations in the principal industrial towns of the United Kingdom, is the first instalment of the comparative investigation which has been undertaken by the Board of Trade with regard to working-class conditions in the principal commercial countries. The next volume, the materials for which are practically completed, will deal with the principal towns of Germany; the inquiry in France is also in an advanced stage of progress. The results

now published for the United Kingdom are of great interest in themselves, and will, it is hoped, furnish a convenient standard for international comparisons. The present investigation is principally concerned with workmen's cost of living (rents, retail prices, &c.), inasmuch as rates and wages and earnings form the subject of a separate and elaborate inquiry by the Board of Trade just now in progress. A great amount of original material as to the rents ordinarily paid by the working classes for their housing accommodation, and the prices usually given by them for food and fuel in most of the large industrial towns in the United Kingdom, has been got together. One of the most remarkable facts brought out by the inquiry is the high level of rents which prevails in London as compared with the rest of the country. It is, of course, a matter of common knowledge that the workman has to pay more for housing accommodation in London than in other parts of the country, but the extent of the differences brought out very clearly in the present investigation will come as a surprise to many.

So far as towns outside the metropolitan area are concerned, the difference between one town and another, having regard to accommodation, is small, although the character of the accommodation differs widely. Outside London, the highest mean rental is shown by the northern counties and Cleveland, a group which includes the Tyneside towns of Newcastle, Gateshead, and Jarrow, where the rents are distinctly higher than in the other towns of the group. The lowest rental is shown in the eastern counties; there the towns lie in an agricultural district, where land is cheap and wages generally low, two facts which have an influence upon the cost of building. The proximity of Peterborough to important brick-fields has also its influence in keeping down prices, but in the eastern counties, as in fact throughout the whole country, the causes of the differences in the rent levels of the towns are very obscure. The fifteen midland towns are the lowest group but one. In contrast to the Midlands the towns of Lancashire and Cheshire show very wide variations in rent levels. There, great variety exists in the kinds of houses found in different parts of the counties, but nevertheless it appears possible to distinguish certain characteristic types. One type of dwelling is found to be more or less prevalent throughout the country. In the midland and the southern counties it is the predominant feature, though elsewhere it is often overshadowed in importance by local types. This is the small four or five-roomed cottage, containing on the ground floor a front parlour, a kitchen and a scullery built as an addition to the main part of the house, and on the upper floor, the bedrooms, the third bedroom in the five-roomed house being built over the scullery. Variations in this type are numerous, but not as a rule characteristic of particular districts. The "back-to-back" house may be said to be typical of Yorkshire, and almost confined to the industrial towns of that county. The type of house chiefly identical with Lancashire, is a square building containing two and sometimes three bedrooms on the first floor, and downstairs a front and back kitchen, the back kitchen serving also (and in some cases exclusively) as a scullery. In the Tyneside towns there is the "Newcastle" or "Cottage" flat, which consists of one floor of a two-storied house, and is entirely self-contained, having its own separate entrance both from the street and from the backyard. Within recent years, this type has become familiar in many of the outer districts of London, but otherwise it is confined almost exclusively to Newcastle and the neighbouring towns. The Welsh towns on the whole conform also to southern conditions, but in Merthyr Tydfil many of the houses have no separate sculleries, whilst a local type of some interest is a 4-roomed house in which one of the ground floor rooms, instead of being designed as a living room or parlour, is a bedroom. The sanitary methods in vogue in the various towns appear to group themselves broadly according to geographical conditions. Generally it may be said that sanitation improves in London from north to south. In the northern group Newcastle-on-Tyne is the only large town in which upwards of 75 per cent. of the houses are provided with sanitary equipment upon the water-carriage system, elsewhere dry conveniences of various types predominate. In the Midland group most of the towns are separately served with the water-carriage, and in the southern and Welsh groups there are very few towns in which that system has not been completely installed.

With regard to the high level of rents prevailing in London as compared with the rest of the country the facts are conveniently summarised in the following table:—

PREDOMINANT RANGE OF WEEKLY RENTS (INCLUDING ALL RATES).

	London.	Provincial Towns.
Two Rooms..	4s. 6d. to 7s. 6d. ..	3s. od. to 3s. 6d.
Three Rooms.	6s. od. to 9s. od. ..	3s. 9d. to 4s. 6d.
Four Rooms..	7s. 6d. to 10s. 6d. ..	4s. 6d. to 5s. 6d.
Five Rooms ..	9s. od. to 13s. od. ..	5s. 6d. to 6s. 6d.
Six Rooms ..	10s. 6d. to 15s. 6d. ..	6s. 6d. to 7s. 9d.

It will be seen that while the mean rent for two rooms in London is 6s., in the provinces it is only 3s. 3d. For three rooms in London the mean rent is 7s. 6d. as compared with 4s. 1½d. in the provinces. The corresponding figures for four rooms are 9s. and 5s. respectively. For five rooms, 11s. and 6s., and for six rooms, 13s. and 7s. 1½d. Croydon and Plymouth and Devonport are the next most highly rented towns to London, the first of these being practically part of London, but even in these places rents are nearly 20 per cent. lower than in the metropolis. The average rents in the towns included in the enquiry are from 50 per cent. to 60 per cent. of those prevailing in London.

HOME INDUSTRIES.

London Passenger-Carrying Companies.—To-day is the date by which the holders of the profit-sharing notes, affected by the proposed readjustment of the capital of the Underground Electric Railways Company, Limited, are requested to deposit their notes in exchange for the new securities offered. These notes were issued fifteen years ago to the amount of £7,000,000. At the beginning of last year their quotation was 90; recently they have stood at about 40 per cent. The proposal is to issue to the note holders, in exchange for their notes, 40 per cent. of their nominal value in 4½ per cent. bonds and 70 per cent. of their nominal value in income bonds. The interest on the 4½ per cent. bonds cannot at present be paid out of profits, but the Company has made arrangements whereby it will be secured until 1912. For some years, at any rate, no interest will be paid on the income bonds, and the owners of the existing profit notes which fall in with the arrangement will get a return of only £1 16s. for each £100 of their present investment. Nor is early improvement upon this probable, or even possible, seeing that the Company are issuing £1,000,000 additional capital in the form of 5 per cent. prior lien bonds, the interest on which is a first charge on the profits. This rearrangement of capital is alluded to because it illustrates the unprofitable character of the London passenger-carrying business at the present time. The Underground Electric Railways Company, of London, is the virtual owner of the three tubes opened within the last few years, and, notwithstanding the efficient management of these lines, the company controlling them has had to go into voluntary liquidation, and to offer its proprietors the terms mentioned above. What used to be known as the underground lines afford further illustration of the effect of excessive competition. The value of the Metropolitan Railway Company's stock has fallen from nearly par to about 40, and the District Company, are seeking powers to issue a new stock to have priority over their existing debentures. The sudden and great increase in the travelling facilities of the metropolis seem to have exceeded the necessities of the case, with disastrous results to all concerned, to the old underground lines as to the new, and to the omnibus companies as well as the railroads. Yet it is in contemplation to ask the public for another £3,000,000 for the construction of a new tube, through a district which, whatever may have been the case when Parliament granted the borrowing powers in 1899, would seem at the present time to be adequately served by existing companies.

Welsh Colliery Profits.—There is reason to believe that the average return last year on capital invested in the Welsh coalfields was the largest on record. The only period challenging comparison is that of 1900-1. In individual cases the profit made in those years was no doubt greater than any made in 1907, but, taking the average, it was higher last year. And whereas the exceptional prosperity of the earlier period was due almost exclusively to the South African war, that of last year must be attributed to the expansion of the world's trade, and the capacity of the Welsh colliery owners to take advantage of it. The annual statements of accounts of most of the Welsh Colliery Companies have now been issued, and taking fourteen of them it will be found that the minimum rate of ordinary dividend paid by them was 10 per cent., twelve of them having increased their rates of distribution, as compared with 1906, by from 5 per cent. to 20 per cent. On a total capital including debentures of £13,000,000 twenty-one Welsh Colliery Companies distributed out of profits exceeding £2,250,000, over £1,000,000 in ordinary and preference dividends, equivalent to an average dividend of over 9 per cent., over 50 per cent. of the gross profits being utilised, partly in strengthening the financial position of the companies by increasing reserve funds or augmenting forward balances, and partly in developments and improvements.

The Nationalisation of the Railways. — The statement of the Chancellor of the Exchequer, at Manchester, that he "would wish to see re-organised the great inland transport system of this country, so as to get rid of the wasteful competition which is a burden upon the industry, and the trade, and the commerce of the country," has been taken, in some quarters, to mean that the Government are not indisposed to consider favourably the nationalisation of the railways of the country. It does not seem probable that the present Ministry will find time and opportunity, even if there be inclination, to attempt this gigantic industrial revolution. Probably the experiment of nationalisation, if it is to be made at all, will first be made in Ireland, where it would be supported by many who would strongly oppose its adoption by Great Britain. The experience of Belgium is often quoted in support of nationalisation, and if State ownership is likely to prove an unqualified success anywhere it should be in Belgium, a compact, densely-populated country, whose industries and agriculture are exceptionally well developed, while her geographical position enables her to compete for the transport across her territory of those vast quantities of commodities which are always passing between the countries of Central Europe and the lands beyond the seas. Moreover, the country is flat, and fuel and labour are cheap. Up to recently it has been assumed that the nationalisation of the Belgian railways has been a success, but M. Marcel Peschaud in France, and Mr. E. A. Pratt, and others in this country, give weighty reasons in support of a different conclusion. Among the objections to nationalisation, are the excessive centralisation it causes, swollen staffs, lack of initiative and elasticity, slackness of control, and inefficient working. Mr. Lloyd George apparently thinks that there would be a great saving by the avoidance of competition, but M. Peschaud shows that whereas in 1905 the propor-

tion of expenditure to receipts on Belgian lines worked by companies stood at 45 per cent., it was 61·97 per cent. on the State-owned lines. On the English railways the proportion in the same year was 62 per cent. It may be recalled that in 1865 a Royal Commission on Railways which had exhaustively inquired into the question of applying the principle of State ownership of railways in this country, came to the conclusion that it would be "inexpedient at present to subvert the policy which has hitherto been adopted of leaving the construction and management of railways to the free enterprise of the people under such conditions as Parliament may think fit to impose for the general welfare of the public." Much has happened since 1865, but probably this opinion still represents that of the great majority of the merchants and traders of the United Kingdom.

Scotch Tweed.—The annual report of the South of Scotland Chamber of Commerce refers to the recent Glasgow prosecution of traders for selling as Scotch tweed cloth which did not come up to the Chamber's definition of Scotch tweed, namely, "An all-wool cloth made in Scotland from yarn spun in Scotland." The defence did not attempt to contradict the definition of Scotch tweed adopted by the Chamber, and the Sheriff accepted it as authoritative, remarking that the expression "all wool" added nothing to the expression "Scotch tweed," and that the adoption of the two expressions was redundant. It is thought that the result of the three prosecutions will benefit the trade of the district to a considerable extent; but as was shown at the recent meeting at Hurdick, many manufacturers are unwilling to accept the definition of Scotch tweeds propounded by the South of Scotland Chamber of Commerce, and accepted by the Sheriff. They all desire to keep up the standard as being all wool, but the condition as to yarn spun in Scotland cannot, it is urged, be maintained, as for years past the firms doing the most prosperous business have been using yarns spun in Yorkshire and in Belgium.

Iron, Steel, and Shipbuilding.—The exports of iron and steel and manufactures in metal during the first three months of 1908 show a serious falling off as compared with the corresponding period of 1907. Reckoned in percentages decreases are as follows:—Pig iron, $37\frac{1}{2}$ per cent.; rails, $15\frac{3}{4}$; galvanised sheets, &c., 26; iron bars, rods, &c., 21; block plates, &c., 23; spiegel and ferro, 58; ship and boiler plates, 30; tin plates, 1. It must of course be remembered that the comparison is with abnormally large figures, and that the total trade in the first quarter of 1908 is not very much below the average over a series of years, but the actual contraction must have its bearing upon prices. As for shipbuilding, the decrease in the output of the United Kingdom was 1,876,610 tons less in 1907 than in 1906, and this year the decrease is likely to be still more marked. As was shown in these Notes last week the output for the past quarter was smaller than for any similar period since 1895. And at the moment it looks as if the labour dispute will end in something like a national lock-out.

OBITUARY.

BENJAMIN WARNER.—Mr. Warner, the well-known silk and velvet manufacturer, died at Wanstead, on Saturday, 25th inst. Born in 1828, he early entered the weaving business which, father and son, had been carried on by his family in England since 1685, when the revocation of the Edict of Nantes drove the Huguenots to this country. The Warner family first settled at Canterbury, and the book of patterns they brought with them, inscribed with the date 1684, can still be seen at the Newgate-street warehouse of Messrs. Warner and Sons. About the beginning of the nineteenth century the Warners moved to Spitalfields, and it was there that Benjamin Warner received his early training. At that time (1850) the English silk trade was at its zenith, and some 50,000 persons were engaged in its various branches in the Spitalfields district. With the removal of the duties on silk, in 1860, the industry immediately and rapidly declined, so that it has been doubted if there are 200 weavers left in London to-day. The great silk manufacturers for the most part left the trade, and those who remained were in many cases ruined. Mr. Warner, however, realised the new conditions, and set himself to face them. He confined himself to the manufacture of the choicest and most costly fabrics, and the productions of the great silk mills at Braintree, in Essex, have long been in great demand at home and abroad, especially in India, the United States, and Germany.

Mr. Warner was elected a Member of the Society of Arts in 1883. When Sir Purdon Clarke read a paper on "English Brocades and Figured Silks," on April 12th, 1892, Mr. Warner joined in the discussion, as he did eleven years afterwards, when his son, Mr. Frank Warner, read a paper on "The British Silk Industry."

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MAY 6.—"The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds." By LOVELL N. REDDIE. SIR WILLIAM PREECE, K.C.B., F.R.S., will preside.

MAY 13.—"The Underground Water Supplies of the Thames Basin." By CLAYTON BEADLE. SIR RICHARD MELVILL BEACHCROFT, Chairman of the Metropolitan Water Board, will preside.

MAY 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. MARTIN DUNCAN.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

MAY 21.—"The United Provinces of Agra and Oudh." By SIR JAMES JOHN DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 4...Farmers' Club, Whitehall-rooms, Whitehall-place, S.W., 4 p.m. Mr. E. S. Salmon, "Fruit Growing and the Conditions under which it may thrive."

Royal Institution, Albemarle-street, W., 5 p.m. (General Monthly Meeting.)

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7½ p.m. Prof. R. H. Smith, "The Design and Waste and Wear of Wheel Teeth."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. G. T. Morgan, "The Manufacture of Sodium Nitrate." 2. Dr. Watson Smith, junr., "Some simple and mixed Esters of Cellulose. The Alkaline Decomposition of Nitro-Derivatives of Cellulose and other Carbohydrates." 3. Mr. E. Hatschek, "The Mechanism of Filtration." 4. Mr. E. Linder, "Metanil Yellow: Its Use as a Selective Indicator." 5. "Dr. J. Lewkowitsch, "The Conversion of Oleic Acid into Stearic Acid."

British Architects, 9, Conduit-street, W., 8 p.m. (Annual Meeting.)

Actuaries, Staples-inn-hall, Holborn, W.C., 5 p.m.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Prof. H. Ami, "Comparative Studies and Deductions on the Geology of the Eastern Front of the American Continent and the Western Front of Europe."

TUESDAY, MAY 5...Royal Institution, Albemarle-street, W., 3 p.m. Mr. G. Stoney, "The Development of the Modern Turbine and its Application." (Lecture II.)

Alpine Club, 23, Savile-row W., 8½ p.m.

Photographic, 66, Russell-square, W.C., 8 p.m. Mr. L. E. Clift, "The Half-Tone Process."

Anthropological, 3, Hanover-square, W., 8½ p.m.

WEDNESDAY, MAY 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Lovell N. Reddie, "The Gramophone, and the Mechanical Recording and Reproduction of Musical Sounds."

Geological, Burlington-house, W., 8 p.m. 1. Rev. E. C. Spicer, "Solution-Valleys in the Glyme Area (Oxfordshire)." 2. Dr. Alfred Prentice Young, "The Stratigraphy and Structure of the Tarnthal Mass (Tyrol)." 3. Mr. George C. Crick, "Note on Two Cephalopods, collected by Dr. A. P. Young on the Tarnthal Köpfe (Tyrol)."

Royal Archæological Institution, 20, Hanoverr square, W., 4½ p.m. Mr. J. W. Willis-Bund, "South Wales and the Religious Orders."

British Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, MAY 7...Royal, Burlington-house, W., 4½ p m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. H. M. Bernard, "Colony Formation as a Factor in Organic Evolution." 2. Mr. C. Forster-Cooper, "Antipatharia from the Voyage of H.M.S. *Sealark*." 3. Mr. G. A. Boulenger, "A List of the Freshwater Fishes, Batrachians, and Reptiles obtained by Mr. J. Stanley Gardiner's Expedition to the Indian Ocean." 4. Mr. F. Martin Duncan, "A Cinematographic Representation of the Movements of *Peripatus* and other Invertebrate Animals."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. K. J. P. Orton and R. W. Everatt, "The Interaction of Diazonium Salts with Mono and Di-Hydric Phenols and with Naphthols." 2. Messrs. J. C. Irvine and D. McNicoll, "The Condensation of Benzoin with Methyl Alcohol." 3. Messrs. O. Flaschner and B. MacEwen, "The Mutual Solubility of α-Methylpiperidin and Water." 4. Mr. P. W. Robertson, "The Melting Points of the Anilides, p-Toluidides and α-Naphthylamides of the Normal Fatty Acids." 5. Mr. J. C. Philip, (*a*) "The Refraction and Dispersion of Triazo Compounds." (*b*) "The Dissociation Constants of Triazoacetic and α-Triazopropionic Acids" 6. Mr. W. N. Hartley, "The Absorption Spectrum of Camphor." 7. Mr. C. E. Fawsitt, "The Viscosity of Solutions." 8. Messrs. H. R. Pickard and J. Yates, "The Action of Fused Potassium Hydroxide and of Hydrogen Peroxide on Cholesterol." Preliminary Note. 9. Messrs. A. Harden and W. J. Young, "The Fermentation of Mannose and Fructose by Yeast Juice." Preliminary communication. 10. Messrs. W. R. Lang and J. O. Woodhouse, "The Volumetric Estimation of Silver." 11. Messrs. F. B. Power and F. Tutin, (*a*) "The Constituents of Olive Leaves;" (*b*) "The Constituents of Olive Bark."

Royal Institution, Albemarle-street, W., 3 p.m. M . W. Bateson, "Mendelian History." (Lecture II.)

Civil and Mechanical Engineers, Caxton-hall, Westminster, S.W., 8 p.m. Mr. E. Fiander Etchells, "Abbreviated Formulæ for Structural Engineers."

Electrical Engineers (at the HOUSE OF THE SOCIETY OF ARTS), John-street, Adelphi, W.C., 8 p.m. Mr. F. Mansbridge, "The Manufacture of Electrical Condensers."

FRIDAY, MAY 8...Royal Institution, Albemarle-street, W., 9 p.m. Mr. J. G. Buchanan, "Ice and its Natural History."

Astronomical, Burlington-house, 5 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Royal College of Science, South Kensington, S.W., 8 p.m. 1. Dr. C. V. Burton, "A Modified Theory of Gravitation." 2. Mr. C. S. Whitehead, "An Examination of the Formulæ for the Grading of Cables." 3. Mr. R. M. Archer, "Illustrations of Geometrical Optics."

SATURDAY, MAY 9...Royal Institution, Albemarle-street, W., 3 p.m. Mr. G. F. Scott Elliott, "Chili and the Chilians." (Lecture II.)

Journal of the Royal Society of Arts

No. 2,894. VOL. LVI.

FRIDAY, MAY 8, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, MAY 13, 8 p.m. (Ordinary Meeting.) CLAYTON BEADLE, "The Underground Water Supplies of the Thames Basin."

Further details of the Society's meetings will be found at the end of this number.

CONVERSAZIONE.

The Society's Conversazione this year will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Thursday evening, the 2nd July, from 9 to 12 p.m.

The programme of arrangements will be announced in future numbers of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

TWENTIETH ORDINARY MEETING.

Wednesday, May 6, 1908; SIR WILLIAM HENRY PREECE, K.C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Li Chun, His Excellency Admiral, The Admiralty, Tien Ping Kai-street, Canton, China.
Low, Charles Ernest, I.C.S., Central Provinces and Berar Exhibition, Nagpur, C.P., India.
Scott-Atkinson, Richard, M.I.E.E., Jesselton, British North Borneo.
Simmons, Rev. Hugh, Mascotte, George-street, Brisbane, Queensland, Australia.

The following candidates were balloted for and duly elected members of the Society:—

Brown, Lawrence Combe, Department of Agriculture, Kwala Lumpur, Selangor, Federated Malay States.
Carvalho, David N., 265, Broadway, New York City, U.S.A.
Collier, George H., "Woodcote," 17, Southend-road, Beckenham.
Corfield, Wilmot, 25, Mangoe-lane, Calcutta, India.
Furnival, Samuel B., Hilltop House, Stoke-on-Trent.
Golds, Alfred, M.R.San.I., Royal Engineer Office, Bordon Camp, Hants.
Pillai, A. R., Trivandrum, Travancore, South India.
Tagore, Abanindro Nath, 6, Dwarka Nath Tagores-lane, Calcutta, India.

The paper read was—

THE GRAMOPHONE, AND THE MECHANICAL RECORDING AND REPRODUCTION OF MUSICAL SOUNDS.

By LOVELL N. REDDIE.

The mechanical recording and reproduction of sounds has already been dealt with in papers read before this Society. The talking-machine was introduced to the Society on May 8, 1878, by Sir William Preece; on the 28th November, 1888, Colonel Gouraud read a paper entitled "The Phonograph;" and on the 5th of December of the same year, Mr. Henry Edwards read a paper on "The Graphophone." I do not propose this evening to go over the ground covered by these three papers, which deal with the discovery of the talking-machine, and the improvements made in it up to twenty years ago, but I shall deal more particularly with the invention and the development of a later type of talking-machine, and shall describe the various industrial and other processes, which are connected to-day with the recording and reproduction of sound by means of this machine.

Before going further, I should like to call your attention to two of the instruments before you; the larger machine is one of the latest models of the gramophone, and the smaller is one of the

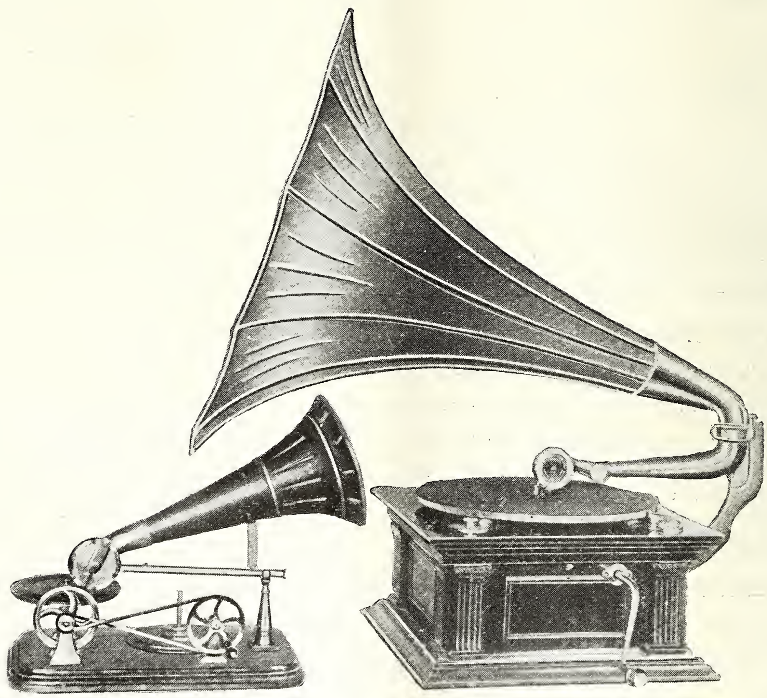
earliest types. (Fig. 1.) The difference in appearance of the two machines is striking; but it is small compared with the difference in their capabilities, and, if you will allow me, I will make this apparent by endeavouring to obtain an audible reproduction from the old-fashioned type, and will then play a short selection on the up-to-date instrument.

The progress made towards perfection during the period of twenty years since the invention of the gramophone has been very considerable, and so rapid has it been in recent years, that too many people to-day, when they hear the word "gramophone" mentioned immediately think of an instrument like this (small machine) and of the sounds which it produced just now. The particular lines upon which improvements have been carried out I will deal with later.

The gramophone was invented by Mr. Emile Berliner. In 1870 he left his home in Germany and went to America, where he worked for a number of years with great success on telephone construction. He afterwards turned his attention to the improvement of the talking-machine, and on May 4th, 1887, just twenty-one years ago, he filed an application for patent in the United States, and a corresponding application in this country in November of the same year. On May 16th, 1888, he exhibited his invention before the Franklin Institute, Pennsylvania.

At the date of Mr. Berliner's invention, machines for recording and reproducing sound were already known and in use. Some ten years earlier, in 1878, Mr. Thomas A. Edison had patented the first practical talking-machine, and he termed the recording machine, the record, and the reproducing machine a phonograph, a phonogram, and a phonet respectively. In 1885 the graphophone

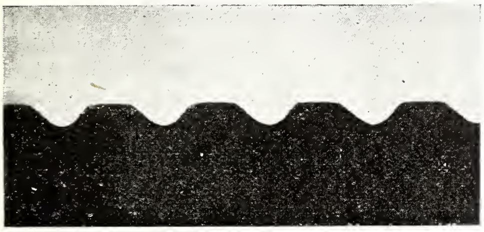
FIG. 1.



was invented by Professor Graham Bell and Mr. C. S. Tainter, of telephone fame, who, working as the Volta Laboratory Association of Washington, had been studying the problem of recording and reproducing sound for some years. The fundamental principles on which these two instruments, the phonograph and graphophone, worked were the same. In each case the sound-waves set up in the air by any source of sound were allowed to strike a delicately held diaphragm which vibrated under the impact of the sound waves. The vibrations of the diaphragm were made to leave a record on a suitable medium, and this sound record was in turn used to perform the inverse operation when it was required to reproduce the recorded sounds; that is to say the record was made to vibrate a sensitive

diaphragm, and this set up in the air particular waves, which conveyed to the ear of the hearer the impression of sound. The essential difference between the Edison and the Bell and Tainter types of sound recording and reproducing machines lay in the manner in which the vibrations of the diaphragm were recorded; for while Edison's invention consisted in *indenting* a record with an up and down sound line, Bell and Tainter obtained a record by *cutting* an up and down line in a suitable medium. According to both these inventions, therefore, the vibrating diaphragm was made to produce on the surface of the record a sound line of varying depth. Berliner on the other hand traced or cut his record in the recording medium in the form of a sinuous line of uniform depth (See Fig. 2), "substantially" as

FIG. 2.



SECTION ACROSS SOUND-LINES OF GRAMOPHONE RECORD. (Magnified 50 diam.)

he says in his Patent Specification, "in the manner of the phonautograph," invented in 1857 by Léon Scott.

The idea of recording and reproducing speech on this system had also occurred to a Mr. Charles Cross, a Frenchman, who on April 30th, 1877, deposited a sealed packet with the Académie des Sciences, Paris, in which he disclosed the idea of reproducing sound by means of a permanent metal record obtained from a Scott phonautograph by photo-engraving through the coating of lamp-black in which the sound line was traced. Thus he anticipated Berliner, and Edison as well, as far as the idea went; but he cannot be said to have disclosed the means of carrying his ideas into practice. Mr. Berliner only became aware of this gentleman's invention three months after he had filed his own application for a patent. In the *Electrical World* of November 12th, 1887, in which he first made public his invention of the gramophone, he writes of Mr. Cross as follows:—"Although he had virtually abandoned his invention, the fact remains that to Mr. Charles Cross belongs the honour of having first suggested the idea of and a feasible plan for mechanically reproducing speech once uttered."

The reasons which led Berliner to adopt a different system of recording and reproducing sound from that employed by Edison and the Volta Association, are clearly set out in the introduction to his first Patent Specification, No. 15232 of 1887, where he says:—

"By the ordinary method of recording spoken words or other sounds for reproduction, it is attempted to cause a stylus attached to a vibratory diaphragm to indent a travelling sheet of tinfoil, or other like substance, to a depth varying in accordance with the amplitudes of the sound waves to be recorded. This attempt is necessarily more or less ineffective, for the reason that the force of a diaphragm vibrating under the impact of sound waves is very weak, and that in the act of overcoming the resistance of the tinfoil, or other material, the vibrations of the diaphragm are not only weakened, but are also modified. Thus, while the record contains as many undulations as the sound which produced it, and in the same order of succession, the character of the recorded undulations is more or less different from those of the sounds uttered against the diaphragm. There is, then, a true record of the pitch, but a distorted record of the quality of the sounds obtained.

"With a view of overcoming this defect, it has been attempted to engrave, instead of indent, a record of the vibrations of the diaphragm, by employing a stylus, shaped and operated like a chisel, upon a suitably prepared surface; but, even in this case, the disturbing causes above referred to are still present. In addition to this, if in the apparatus of the phonograph or graphophone type, it is attempted to avoid the disturbing influence of the increase of resistance of the record surface, with the depth of the indentation or cut as much as possible, by primarily adjusting the stylus so as to touch the record surface only lightly, then another disturbing influence is brought into existence by the fact that with such adjustment, when the diaphragm moves outwardly, the stylus will leave the record surface entirely, so that part of each vibration will not be recorded at all. This is more particularly the case when loud sounds are recorded, and it manifests itself in the reproduction, which then yields quite unintelligible sounds.

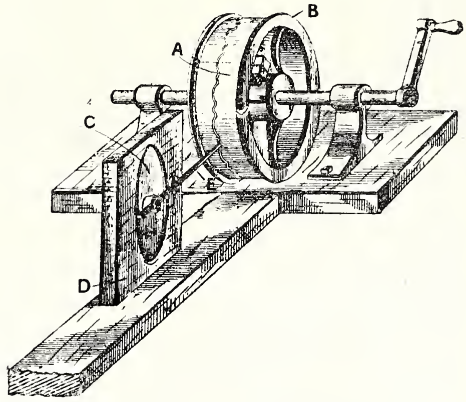
"It is the object of my invention to overcome these and other difficulties by recording spoken words or other sounds without perceptible friction between the recording surface and the recording stylus, and by maintaining the unavoidable friction uniform for all vibrations of the diaphragm. The record thus obtained, almost frictionless, I copy in a solid resisting material, by any of the methods hereinafter described; and I employ such copy of the original record for the reproduction of the recorded sounds.

"Instead of moving the recording stylus at right angles to, and against the record surface, I cause the same to move under the influence of sound waves parallel with and barely in contact with such surface, which latter is covered with a layer of any material that offers a minimum resistance to the action of the stylus operating to displace the same."

He then proceeds to a detailed description of his instrument, which he terms a "gramophone."

Nowadays the term "phonograph" is popularly applied to a sound-reproducing machine which plays a cylinder record, while "gramophone" is often incorrectly used for any disc machine. This distinction is not, however, correct. It is a fact worth noting that the first figure of the drawings in Berliner's original patent shows a record wound

Fig. 3.



on a *cylindrical* support, whereas the first figure in Edison's patent shows a *disc* record, thus directly contradicting the popular distinction just referred to.

According to the specification of his first patent, Mr. Berliner made his sound record as follows:—He took a strip of paper, parchment, or metal, A (Fig. 3), stretched it round a drum, B, and coated it with a layer of lampblack, or other substance which could be easily removed by the point of the stylus. He provided a diaphragm, C, which was held by its edges in a casing, D, and to the centre of this diagram he attached one end of the recording stylus, E. This stylus or bar was fulcrummed halfway down to the side of the diaphragm casing, and the other end was left free to move in accordance with the vibrations of the diaphragm under the impact of the sound waves. The point of the stylus lightly touched the strip on which the record was to be traced, and as the diaphragm was spoken against, and the drum rotated, the stylus removed the lampblack from the record in a sinuous undulating line. The record thus obtained he proposed to preserve by coating it with varnish or the like. For the purpose of reproduction he copied the record in a resisting material, either mechanically, by engraving, or by etching, or photo-engraving, and this gave him a permanent record, consisting of a wavy grooved line in a strip of copper, nickel, or other material. To reproduce the sounds recorded, this strip was in turn stretched round a drum, the point of the stylus placed in the groove, and the drum rotated. This caused the diaphragm, to which the other end of the stylus was attached, to vibrate and reproduce the recorded sounds. The specification continues:—

"In the phonograph and graphophone the end of the reproducing stylus which bears upon the indented or engraved record, has a vertical upward and downward movement; it is forced upwardly in a positive manner by riding over the elevated portion of the record, but its downward movement is effected solely by the elastic force of the diaphragm, which latter is always under tension. In my improved apparatus the stylus travels in a groove of even depth and is moved positively in both directions; it does not depend upon the elasticity of the diaphragm for its movement in one direction. This I consider to be an advantage, since by this method the whole movement of the diaphragm is positively controlled by the record, and is not affected or modified by the physical conditions of the diaphragm, which conditions necessarily vary from time to time, and constitute some of the causes of imperfect reproduction of recorded sounds."

It is this feature of the positive control of the diaphragm, coupled with the uniform friction and resistance in the cutting operation, and the consequent accurate tracing of the curve of the sound wave, that has brought the Berliner type of machine to the forefront as a musical instrument. While the cylinder machine with the up and down cut offers advantages for making records at home and for office work, being handier, for instance, than the disc recording machine, it has not been found possible to obtain the same truth of reproduction of musical sounds that can be obtained with the gramophone. An examination of the microscopic undulations in the sound wave, which determine its pitch, loudness, and quality or timbre (some examples of which I shall show you presently), will make this easy to understand.

In the second or improved form of gramo-

phone described in Berliner's patent, a flat disc record is used, which, he says, offers advantages for copying purposes. Here a disc of glass is employed, and this is covered preferably with a semi-fluid coating of ink or paint, in which the stylus traces or cuts an undulating line as before. This coating he prefers, because it does not flake, and leave a rough-edged line, like the lampblack record. A turn-table carries the record disc, and is rotated by any suitable means. As it revolves, it is caused to travel slowly sideways past the recording point, so that the sound line takes the form of a sinuous spiral running from the outer edge of the record towards the centre, or *vice versâ*. A permanent record in metal is obtained by photo-engraving.

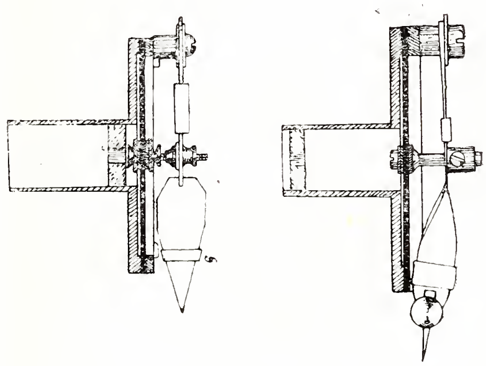
Mr. Berliner's next step was to make a disc record in solid material by direct etching. (U.S. Patent 382790.) To this end he coated a disc or cylinder of zinc or glass with a layer of some substance which, while offering no perceptible mechanical resistance to the movements of the recording stylus, resisted the chemical action of acids. The coating he preferred consisted of beeswax dissolved in benzine. When the recording stylus had traced out its line on the record, and exposed the solid disc below, the latter was etched, and a permanent record produced. Copies could be obtained by the galvano-plastic process, by making a matrix, and impressing discs of hard rubber, or the like. Although this system of etching was considered at the time a great advance in sound recording, it never gave very satisfactory results. Owing to the action of the acid, which besides biting down into the metal also undercut the protective coating, the sound line was always left with rough sides, and this roughness was transmitted to the copies, so that the reproduction was accompanied by a very marked and disagreeable scratching sound.

In 1890, the inventor of the gramophone took out patents for further improvements, and in particular for new forms of diaphragm holder or sound-box, as it is called, one for recording purposes and the other for reproducing. (Fig. 4).

Although at this date, Mr. Berliner himself had spent much time on improving his invention, the gramophone had not yet become a commercial article. It had not even reached the stage of the small machine you see here. It was looked upon as a scientific curiosity, or at best a toy, but not as a machine which could ever be expected to become an instrument of entertainment, and no one except perhaps the inventor ever imagined it would attain its present perfection, or enjoy its present popularity. The phonograph and graphophone had obtained a firm footing and for commercial purposes at any rate, serving for instance as automatic stenographers, and in a lesser degree as instruments of entertainment, had attained success.

The Volta people had patented broadly the system of cutting or tracing a sound line in a solid body, so that even Berliner's own method was within the scope of their patent, and from the point of view of patent rights, Mr. Berliner was at a disadvantage. Moreover, the reproduction he obtained was far behind that given

Fig. 4.



Recording and Reproducing Sound-Boxes, Old Type.

by the phonograph and graphophone, for though in the latter instruments the sound waves were distorted, there was a comparative absence of scratch. Very different is the position to-day when in the United States at any rate practically the whole of the enormous trade in disc machines is subject to a Berliner Patent No. 534543, which covers the use of a freely swinging sound-arm or horn, carrying the sound-box and guided throughout the playing of the record entirely by the sound lines.

It was not until the end of 1897 that the manufacture commenced in the United States of a disc record which quickly made the gramophone popular, and may be regarded as the starting-point of the industry of to-day. Instead of a record made from an etched metal original, a disc record could now be offered to the public made by a new process which allowed many hundreds of good *facsimile* copies to be made from one master record. This process consisted in cutting

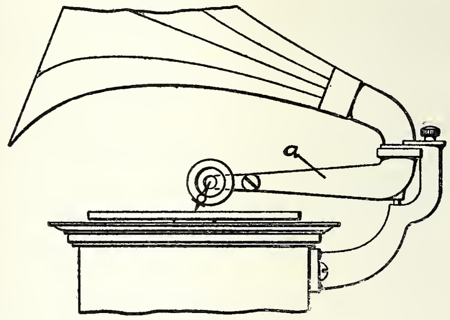
the first record in a disc-shaped blank of wax-like material, obtaining a solid metal negative thereof by electro-deposition, and pressing copies of the original from this negative or matrix in a material which was hard at normal temperatures but became plastic under heat.

About this time a number of inventors began to turn their attention to the improvement of the machine, to keep pace with the vast improvements which were being made in the records. The machine was provided with an efficient governor or speed-regulator, to ensure a uniform speed of rotation of the turn-table. Next the hand-driven machine was abolished altogether, and a machine substituted which was driven by a spring motor. To-day the better class machines are furnished with a motor which will run fifteen minutes or more for one winding of the motor. The speed regulator was furnished with an indicator to show at what speed the machine was running. It will easily be understood how essential it is that the record on reproduction should be revolved at exactly the same pace as the blank on which the original record was cut, if the production is really to be a true reproduction of the original selection; if, for instance, the record is rotated faster, the sound waves set up by the reproducing diaphragm will be produced at a higher speed than that at which the corresponding sound waves fell upon the recording diaphragm. The greater the frequency of the sound waves the higher the note, so that a record, if played too fast, is pitched in a higher key, and a bass solo can be reproduced in a shrieking soprano.

The sound-box went through a series of improvements, the object of the inventors being to render the diaphragm as sensitive as possible either to the sound waves of the selection being recorded, or to the vibrations transmitted to it from the record disc as the case might be. The diaphragm is now lightly held at its edges by hollow rubber gaskets, the fulcrum of the needle connecting the diaphragm to the needle point is formed by knife edges, and its movements are controlled by delicate springs. The standard sound-box of to-day is a very different thing from the early pattern shown in Figs. 1 and 4.

Improvements were further made in the means of conveying the sounds recreated in the sound-box to the ear of the auditor. The old air-tubes had disappeared to give place to a small horn, to the narrow end of which the sound-box was attached. As the popularity of the gramophone grew, the public wanted more sound for its money, and accordingly the size of the amplifying horn was increased. The increased weight of the horn necessitated that a special bracket should be provided to carry it, and the horn was accordingly balanced with just sufficient weight on the sound-box end to keep the needle well in contact with the record. Thus the machine remained for a time; but in this form it did not satisfy its patrons, for it did not do all that they thought might be expected of it. It was found in practice that the turn-table often did not revolve absolutely horizontally, that the record discs were sometimes not absolutely flat, and that the central hole was in reality, but seldom accurately in the centre of the disc. Owing to the rise and fall of the record as it rotated, the end of the amplifying horn also had to rise and fall, and owing to the

Fig. 5.



Tapering Sound Arm (*a*).

eccentricity of the hole in the middle, the sound-box end of the horn was continually approaching and receding from the centre of the record, as it followed the sound lines. In other words, the needle as it followed its path along the sound groove, in addition to transmitting the proper vibrations to the diaphragm, had also to move the whole mass of the amplifying horn. This had two injurious effects; it impaired the reproduction, and it wore out the record.

The next step was to remove the amplifying horn to a short distance from the sound-box and to carry it upon a rigid bracket on the cabinet of the instrument, the sound-box being connected to the small end of the horn by a piece of tubing, which allowed the sound-box to move across the turn-table and also to be raised or lowered above the record. This arrangement offered the advantage that the weight of the horn was carried by the cabinet, and the record had not to overcome the inertia

of the whole horn as before, but only had to move the sound-box and its connecting tubing (or sound-arm as it is called) when the turntable was not horizontal or the hole in the record not central. But though this arrangement offered advantages in one direction, it was found to be accompanied by imperfection waves became distorted and acoustic interference was created. It was not until 1903 that patents were taken out on an invention which overcame this difficulty (See Fig. 5), the invention now known as the taper arm, the patent on which in this country was recently upheld in the Court of Appeal. The

Fig. 6.

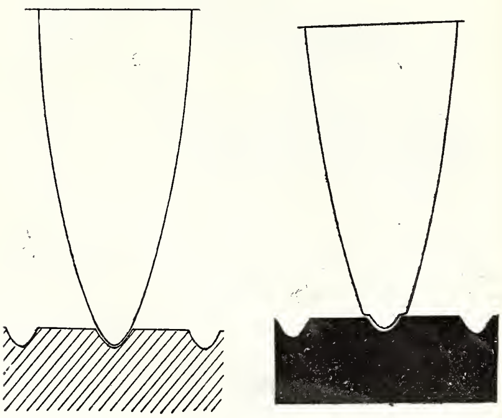
in another. The piece of straight tubing connecting the sound-box and the horn had a distorting effect upon the sound waves. Instead of these waves being able to expand uniformly as they advanced, as had been the case in the old arrangement when they passed straight into the horn, they were forced to pass first of all through this straight pipe where the inventor had hit upon the idea of jointing the amplifying horn itself, so that while the horn could start immediately next the sound-box the latter could be moved with freedom without moving the heavy bell portion of the amplifying horn. The success of this invention was immediate and pronounced, and a tapering sound arm is now almost a *sine qua non*.

It was only to be expected that as the reproduction of the machine improved the form in which it was presented to the public would be made more and more attractive, and hence the handsome cabinets and pedestals with which the gramophone is furnished to-day.

Fig. 6 shows some of the various stages through which the machine passed. The lower instrument on the left-hand side will be recognised as the one before which the dog sat and listened to "his master's voice."

An important item in the reproducing apparatus is the needle. Instead of the same blunt point beng used over and over again as formerly, a new needle is now recommended for each playing of a record. The reason is that the operation of playing

Fig. 7.



a record, wears down the fine point of a needle, so that by the time a record has been played through, the needle point has shoulders worn on it (Fig. 7) with only a central projection left to engage in the sound groove; a point of this shape, when much worn, cannot give a good reproduction. The manufacture of gramophone needles constitutes a small industry in itself, and the number of processes through which the needles go, before they are ready for use, is surprising. Lengths are cut from the best steel wire, and are pointed by emery wheels, rotating about 1,200 times a minute. The needles are cut off, and again the blunt ends are pointed. Some of the machines in use cut off as many as 200,000 needles daily. The needles are now hardened by tempering, being heated in open pans, almost to white heat, and then suddenly cooled; this is a most important process. They then have to be polished. This is done by packing the needles into bags or sacks and rolling them to and fro for days on a reciprocating table; the constant friction of the needles against one another, polishes them bright and smooth.

I will now deal with the series of operations which go to make a finished disc record of the Berliner or gramophone type. The person who is making the record sings or plays immediately before the mouth of a horn or funnel, the object of the horn being to concentrate the energy of the sound waves upon the recording diaphragm. At the narrow end of the horn is the recording sound-box and machine and its attendant expert. The artist is on one side of a screen and the machine on the other, for in all the recording laboratories of talking-machine manufacturers the secrets

Fig. 8.

of the operation of recording are most carefully guarded. I have here a sketch (Fig. 8) drawn by a famous singer of himself making a record. The making of a good record is not so simple a matter for the artist as might appear; he often has to make several trials before he learns just how to sing into the trumpet, how near to stand, &c. When singing loud high notes he must not come too near the mouth of the funnel, as otherwise the vibrations will be too powerful and the result will be what is technically known as "shattering." When the artist is singing or playing to an accompaniment another horn connected with the same sound-box is often provided so that the person of the artist may not obstruct the sound waves of the orchestra or other accompaniment.

The disposition too of the various instruments of an orchestra in the recording-room is of the very highest importance if the best results are to be obtained. The wooden in-

struments are arranged about four feet from the mouth of the trumpet—behind them are the brass instruments, and at the back the bass fiddles and drums.

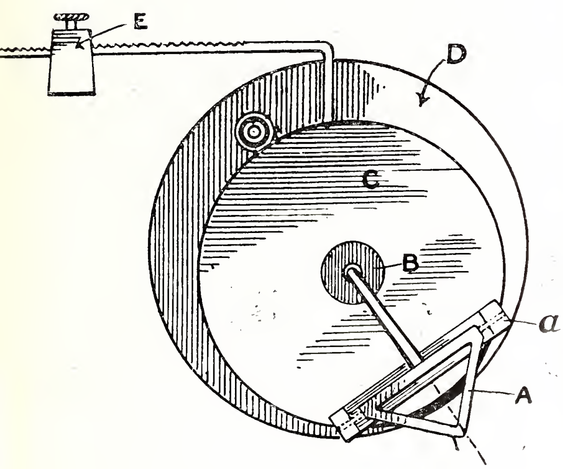
On the other side of the screen a horizontal table, carrying a wax tablet, is rotated beneath the recording sound-box at a fixed and uniform speed, generally about 76 revolutions per minute. As the table rotates it also travels laterally at a fixed and uniform speed, being carried on a revolving threaded spindle, and the wax tablet or blank is thus caused to travel slowly under the stationary recording-box. The sapphire cutting-point of the sound-box is lowered so as to enter the surface of the blank to the depth of about $3\frac{1}{2}$ to 4-1000 of an inch, and as the machine

otherwise the lines would at points break into one another.

The recording blank is made of a soapy wax. Each laboratory has its own receipt for the composition of the blank, but generally speaking the compound is made up of stearin and paraffin. Many other substances have been suggested, amongst which may be mentioned barium sulphate, zinc white and stearin, ozokerit and paraffin.

The consistency of the blank material must be such that it is stiff enough to retain its shape when the sound groove is cut in it, and at the same time it must not be so stiff as to offer any great resistance to the cutting point. It must not chip nor flake, as otherwise the recording point will cut a groove with ragged

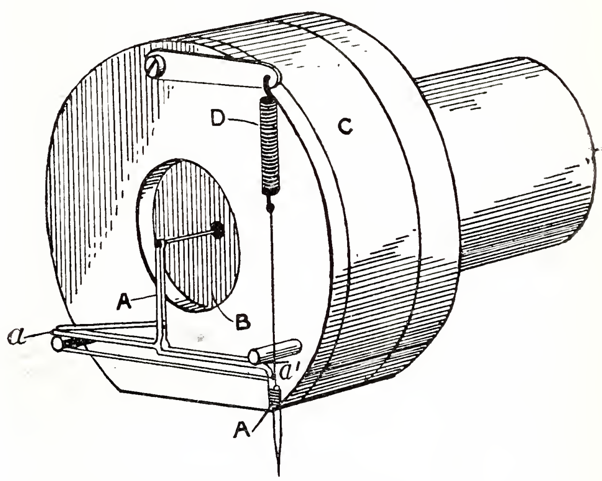
FIG. 9.



RECORDING SOUND-BOX.

A. Stylus. *a*. Stylus bearings. B. Diaphragm.
C. Diaphragm holder. D. Flange of Sound Tube.
E. Counter-weight.

FIG. 10.



RECORDING SOUND-BOX.

A. Stylus. *a*. Stylus bearings.
B. Diaphragm. C. Diaphragm holder.
D. Tension spring.

runs it cuts a fine spiral groove of uniform depth, running from the circumference of the blank to within two or three inches of the centre, according to the length of the selection recorded.

The exact construction of sound-box used for recording is not disclosed by the experts, but we may take as illustrative two forms which are covered by British patents, Nos. 659-01 and 627-01. (Figs. 9 and 10.)

The turn-table travels, as a rule, about 1-100th of an inch laterally for every revolution, so that the spiral cut comes round about 100 times in the width of one inch. It will thus be evident that the lateral undulations of the sound line must be minute in the extreme as

sides, and this will increase the scratching sound made by the needle on subsequently reproducing. The best results are obtained by a tablet of such consistency that the cutting point detaches an unbroken thread or shaving of wax.

The diameter of the recording blank varies, but the maximum diameter employed is about 12 inches. It will be clear that the size of the record cannot be increased beyond certain limits, when it is remembered that the blank is revolved at a uniform speed, and that consequently the outer portion of the blank is running past the recording point at a much higher speed than the inner portion, when this is brought under the recording sound-box.

Thus, with a 12 inch disc, when the cutter is ½ inch from the edge, it will in one revolution describe a line on the record of a length approximately equal to the circumference of a circle of 11 inches diameter—that is to say, 34·5 inches. By the time the recording point has worked in another 3 inches towards the centre of the tablet, the length of its path over the wax will approximately equal the circumference of a circle of 5 inches diameter, or 15·7 inches. The rate of revolution of the tablet being uniform, the sound line at the edge of the tablet is accordingly being cut at more than twice the speed that it is cut at nearer the centre; and the speed at which the recording point can be made to cut the sound groove satisfactorily can only be varied within certain limits. If the diameter of the tablet is increased, the outside speed will be too great for proper recording; and if the speed of the turn-table is correspondingly decreased, the ripples in the sound line near the centre will be too close together and cramped; there will be too many vibrations per inch of sound line to allow of proper recording and reproduction. The obvious solution would be, of course, gradually to increase the speed of the turn-table as the recording point nears the centre of the blank, but there then arises the necessity of using mechanism for securing a corresponding gradual change of speed on the reproducing machine, in order to keep the selection in the proper key. Devices for securing an increasing speed have been invented, but they are not free from objection, and have never come into general use.

The record in wax having been made, the next step is to produce a negative in copper. The wax tablet is dusted with graphite, which is worked into the grooves with a badger hair brush, to make it electro-conductive, and is lowered into the electrolytic bath of copper salt solution. In order that this negative may be able to resist the pressure to which it is subjected in pressing records, it is necessary that the deposition of the copper should be thoroughly homogeneous. To this end, and also in order to hasten the process so that the blank may not be attacked by the solution, the blank is kept continuously in motion in the electrolytic bath. The process is continued until the copper shell is nearly ·9 of a millimetre in thickness. The negative thus formed may be termed the master negative, and from this master a few commercial samples of the record can be pressed by means of which the quality of the record can be tested. It is not, however, usual to press more than two or three records from this negative. Seeing that sometimes as many as six thousand or more copies are sold of a single record, it is natural that the manufacturers should take steps to enable them to multiply copies without injuring their master negative or having it worn out, for it is not usual at this stage to obtain further negatives from the original wax record. They accordingly make duplicates of their master negative, by taking dubs or impresses of the master in a wax composition, from which in turn working matrices are made. Copper shells are obtained from these dubs in the same way as from the original wax tablet, but the metal is only deposited to the thickness of about half-a-milimetre. The shells are made absolutely true and flat at the back, so that any irregularities caused in the electro-deposition may not be transferred in pressing to the front or face of the shell. They are then backed up or stiffened by a brass plate about one-tenth of an inch in thickness. The attachment of the backing plate and matrix is effected by sweating or soldering them together under pressure. The backing plate is supported on a heated table, a thin layer of solder is run over it, the shell is laid upon it and pressed firmly down, with an elastic protective cushion of asbestos, for example, placed over the face or recorded surface of the shell to prevent the sound ridges in it from being injured. The matrix thus obtained is now nickel-plated on the recorded side so as to present a better wearing surface, and after polishing is ready for use in the pressing machine.

Attempts have been made to use a recording blank of conductive material, or containing sufficient conductive material to allow of omitting the subsequent graphiting or metallising of the blank; the objection to this procedure has always been that such substances offered too much resistance to the recording point.

The commercial record is pressed in a substance the essential qualities of which are that it should be hard at normal temperature, but capable of being softened and made plastic by heat. It must be tough and elastic enough not to be easily broken when pressed into discs of about 2½ m.m. in thickness; it must be thoroughly homogeneous; and it must not be gritty in composition, as otherwise it will augment the scratch of the needle, and wear off the point. Finally, the record must be so

hard, when cold, that it will retain the contour of the sound groove, even after it has been played a large number of times. Various substances and compounds have been used or suggested for making records; celluloid, glass, papier-maché, vulcanized rubber, casein, and shellac with an admixture of crocus powder. In nearly all the compounds actually used shellac is the principal ingredient.

The compound usually employed to-day is made up of shellac, wood charcoal, heavy spar (barium sulphate), and earthy colouring matter. Various animal and vegetable fibrous materials, such, for instance, as cotton flock, are added to give the record the required toughness. The several ingredients are first finely ground and then carefully measured and mixed according to formula. The mixture is put into a revolving drum, and the flock added. After being passed through a magnetic separator to remove any metallic particles, it is next mixed by heated rollers until a thoroughly homogeneous plastic mass is obtained. The mass is now passed through calendar machines which roll it out into thin sheets, and as it passes from the calendar it is divided into sections, each section being about the requisite quantity for one record.

The records are pressed in hydraulic presses. The matrix is heated, and placed face upwards in a mould on the lower half of the press, being centred by a pin passing through the middle of it; the label for designating the selection is placed face downwards on the matrix, and on this is placed, in a warm, plastic state, the quantity of material required for one record. The press is operated, and the mass is immediately distributed all over the mould. Both halves of the press are furnished with cooling plates, through which a stream of water can be passed so that the pressing surfaces can be immediately cooled, and the record mass consequently hardens quickly and retains the impressions of the matrix. The record is removed, and its edges are trimmed up with emery wheels; for the record material is too hard to allow of any cutting instrument being used. The record is then ready for sale.

It will be seen that the process of producing a commercial record is a long and intricate one. It is, further, a process or series of processes which have required a very high degree of scientific skill and untiring experimental work to bring the sound record to its present pitch of excellence. There are still objections to be overcome, and perhaps the greatest of these is the hissing or scratching sound produced by the needle in reproduction. There is, however, no reason to doubt that eventually this will be overcome. A material will be found for making the records which will ensure that the sides and bottom of the sound groove are absolutely smooth. Even this, however, will not entirely eliminate the scratch, which must be regarded to some extent as inherent in the sound groove. The recording point makes a slight hissing noise as it cuts the wax, and that means that the recording point is vibrating on its own account, apart from the vibrations which it is conveying from the diaphragm to the wax tablet; consequently we must expect the recording point to be registering its own scratch vibrations as it goes along. These scratch vibrations are exceedingly minute and of a very high frequency, and in the ordinary course might not be heard, were not the diaphragm abnormally sensitive to vibrations of high frequency; the actual result is that the scratch waves are reproduced with proportionately more precision if anything than the musical waves of the selection.

An invention has recently been published which, if practicable, should do much to remove the defect of scratch. According to this invention the stylus of the recording sound-box, instead of cutting a groove in a wax blank, is made to deposit a fine stream of material upon a polished surface. The original record, therefore, has a raised sound line on it, instead of a grooved one. The substance deposited is one which quickly hardens on deposit, so that it will not spread on the polished surface. A negative is made from this original, and the matrix used for pressing is made from this negative.

Much attention has been bestowed on the diaphragm both of the recording and of the reproducing sound-box. Diaphragms have been tried of almost every possible substance. Copper, tin, celluloid, rubber, leather, gold-beater's skin, animal membrane, glass, and mica have all been used, and as many different methods of supporting them in the sound-box have also been tried. The object aimed at is to secure a light and highly sensitive diaphragm, and to hold it in the sound-box so that in vibrating under the impact of the sound waves it will buckle as little as possible, for the effect of buckling is to slightly distort the sound waves. A glass diaphragm is usually employed in recording sound-boxes, one being selected out of a score that may

be tried. Reproducing sound-boxes are now always made with mica diaphragms.

It is interesting to note that steps are to-day being taken in many countries to form collections of voice records of singers, artists, and other famous personages, and that an important part is played by the talking-machine record in science.

In June of 1906 a number of matrices were deposited at the British Museum of records made by well-known artists and others. These have been sealed up, and are not to be taken out for fifty years. Thus records of these artists' voices have been secured for practically all time.

On the 24th December last there were deposited in a vault of the Paris Opera House discs bearing records of the voices of Tamagno, Caruso, Scotti, Plançon, de Lucia, Patti, Melba, Calvé, and other artists. The statute establishing this collection provides that the records shall be taken out and played once every one hundred years. The collection is to be added to every year.

Austria has had a Public Phonogram Record Office since 1903. Dr. Pöch, who recently returned from two years wandering among the tribes of Scuth America, brought with him many records of religious, ceremonial, and other songs, which are of great ethnological interest.

In Germany, although no public office has as yet been established, the German Anthropological Society and the Ethnological Museum each have their collections.

A short time ago the Hungarian Ethnological Museum purchased a number of machines, and appointed a certain Dr. Vikar Bela to travel through Hungary and to make records of the various dialects found there, in order that the folk songs of the people might be preserved. The records have been registered and are preserved in the archives of the Museum.

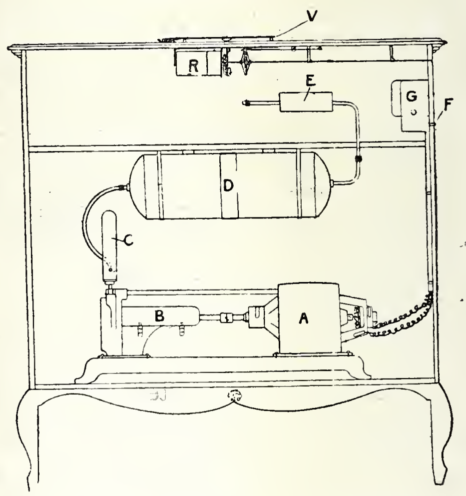
Professor Garner, of the United States, is reported to have taken records of the sounds made by the West African apes, and to be able clearly to distinguish certain sounds betokening, for instance, fear, hunger, friendship. He described how he established himself in a cage in the forest where the apes came and visited him; he held in fact a sort of school which was attended by carefully chosen pupils.

The story is known of Humboldt finding a parrot in Brazil which was able to speak an otherwise extinct Indian dialect. The scientists of the future will, as you see, have more reliable sources of information in the talking-machine record.

I have here some records made by the Pigmies of Central Africa who were brought on a visit to this country by Colonel Harrison. If you will permit me I will give you a Pigmy folk song with national accompaniment.

This paper on Mr. Berliner's invention, and the recording and reproduction of musical sounds, would not be complete if I omitted to refer to another instrument, that now known as the Auxeto-Gramophone or Auxetophone, which works on a differeut principle, but by means of which sound records of the Berliner type can be most effectively reproduced. In this machine the record does not vibrate a diaphragm, but it vibrates a very finely-adjusted valve which controls the flow of a column of air under pressure. As the air passes through the valve there are given to it minute pulsations which correspond to the undulations in the sound record, so that sound waves identical with those originally recorded are set up in the surrounding air and travel to the ear of the hearer.

Fig. 11.



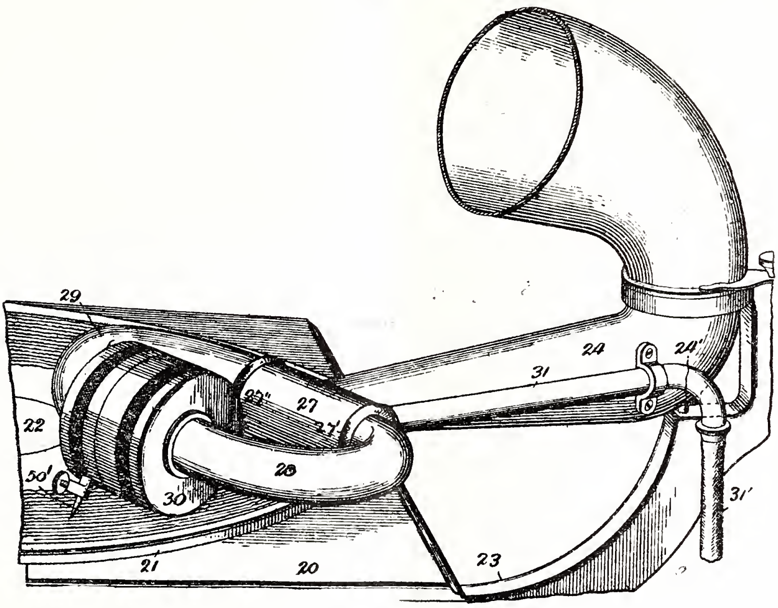
A. Motor. B. Blower. C. Oil Separator.
D. Air Reservoir. E. Dust Extractor. F. Electric Switch.
G. Fuse Box. R. Turntable Motor. V. Turntable.

In the apparatus you see here (Fig. 11), a one-sixth horse-power electric motor drives an air-compressor. The air, after passing through an oil separator or filter, enters a reservoir, which helps to ensure a regular flow of air to the valve. From the reservoir the air passes through a dust collector before it reaches the valve, as the very fine adjustment of the latter

is apt to be interfered with, if particles of dust or oil get into it.

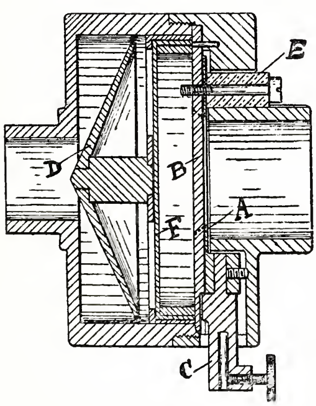
The sound-box, as you will see on referring to the drawing, comprises a vibrating comb or grid valve, rigidly connected to the stylus-bar or needle-holder, and a grid valve-seat. The valve is on the side of least pressure, and is carried by a spectacle

Fig. 12.



Pneumatic Sound-Box and Arm in operation.

Fig. 13.

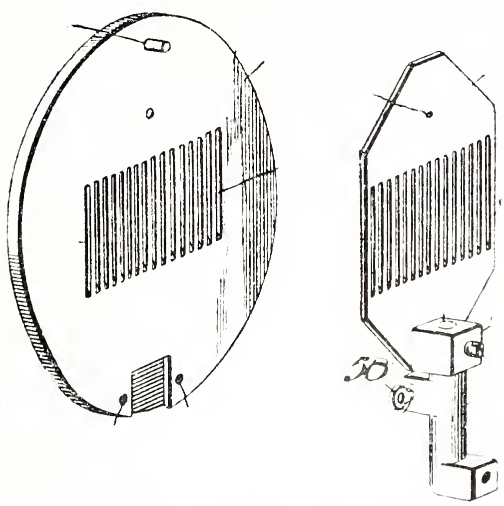


Sectional View of Pneumatic Sound-Box.

spring. (58, Fig. 14.) The air is deflected to the walls of the sound-box by a conical deflector, so that it reaches the whole of the surface of the valve at uniform pressure. A resilient rubber washer holds the grid valve normally against the valve seat. As the needle moves, following the sinuosities of the sound line, the valve moves with it, and thus opens and closes more or less the slots in the valve seat through which the air is rushing. The effect of this I will let you hear for yourselves.

The first practical talking-machine working

Fig. 14.

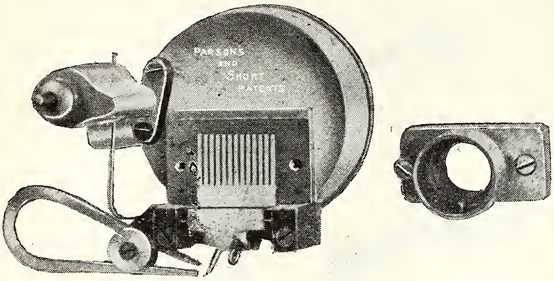


Valve of Pneumatic Sound-Box.

on this principle was made by Mr. Short, who patented his invention in 1898. The Hon. C. A. Parsons then took up the invention, and

considerably improved it. I have a model here of the improved Parsons' sound-box (Fig. 15). The auxetophone sound-box as

Fig. 15.



Parsons' Sound-Box.

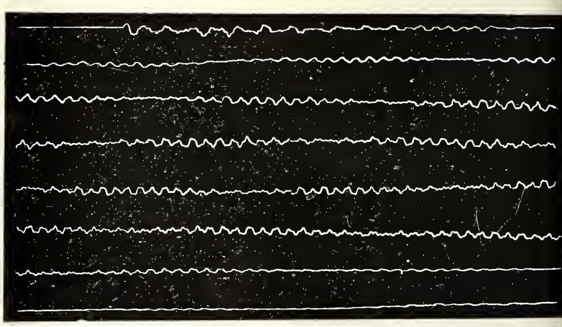
used to-day is on substantially the same lines, though its construction has been simplified.

Before closing this paper I should like to give you some details concerning the sound line in a gramophone record, and show you some magnified tracings of sound waves. The approximate length of the spiral line in a fully recorded 12-inch record, carrying the sound line to within $2\frac{1}{4}$ inches of its centre, is π times the mean diameter multiplied by the number of turns, that is, $\pi \times 8 \times 350$ inches $= 244$ yards 1 foot. But this is the length of the line without the ripples. These at least double its length, if the pitch of the record is high and the sounds recorded rich in harmonics, so that we have a sound line over 480 yards long. It is no wonder that the needle point must be finely tempered, and that it shows signs of wear after playing a record. Its average speed over the record is 31·8 inches per second. For a fundamental note on middle C, this gives us about 8 vibrations per inch.

Fig. 16.

Note of Orchestra: ·5 sec.

Fig. 17.



Gong: ·4 sec.

The tracings which I have here are some made by Prof. Scripture, of Washington, and are reproduced in his interesting work, "Researches in Experimental Phonetics." They are traced by a specially-constructed instrument from actual gramophone records, and they show the sound line on a very much magnified scale.

Fig. 18.

Piano and Whistle: ·1 sec.

Fig. 19.

Plucked String: ·05 sec.

The "time equation" of the tracings shown by Professor Scripture is 1 mm. = 0·0004 sec., that is to say, 1 mm. length of the tracings show the sound waves produced in 0·0004 of a second, or 8·2 feet per sec. The reproductions shown in the Figs. are about half-full size, so that 4·1 feet equals the length of tracing for 1 sec.

Fig. 16 shows the waves of a note of an orchestra, produced in just under ·5 of a second; a vibration with a wave length of about 3 mm. is noticed occurring again and again. These are seen to be grouped in threes, indicating a tone with a period of 9 mm. The presence of loud bass notes is indicated by the greater amplitude of certain waves. There is one which reinforces every sixth vibration; a very complicated curve is the result. It is marvellous that the ear can sift these vibrations so as to distinguish the notes of the various instruments from one another.

Fig. 17 shows the vibrations of a gong. The gong is struck, but the special vibrations do not commence immediately. The curve of the low fundamental has other high vibrations traced in it. When the chief tones of the gong interfere, they produce beats, as shown in the weak portions.

Fig. 18 shows the curve of a whistled note accompanied by piano. The waves of the piano note alone can be distinguished from those where the high whistle vibrations are imposed.

Fig. 19 shows the curve of a plucked spring.

Fig. 20 shows a small portion of a vocal record of an Italian voice on a high note. The rise and fall of the amplitude is noticed, producing a tremolo; the pitch, however, does not rise and fall as it would in a proper trill, which is supposed to be an alternating between two notes. The distinction, however, between the tremolo and trill could not be distinguished by the ear.

Finally, Fig. 21 shows part of a tracing from the legend of "Cock Robin's Death and Burial." It starts with the fly's response "with my little eye, I saw him die." Attention may be drawn to the five repetitions of the vowel sound "ai," in "my," "eye," "I" "die," "I." The curves of the two components, the "ah" and the "e" are easily recognised each time they occur. It will be noticed further that the consonants are practically silent and leave an imperceptible record.

That concludes my paper. I have an instrument here which will enable you to see

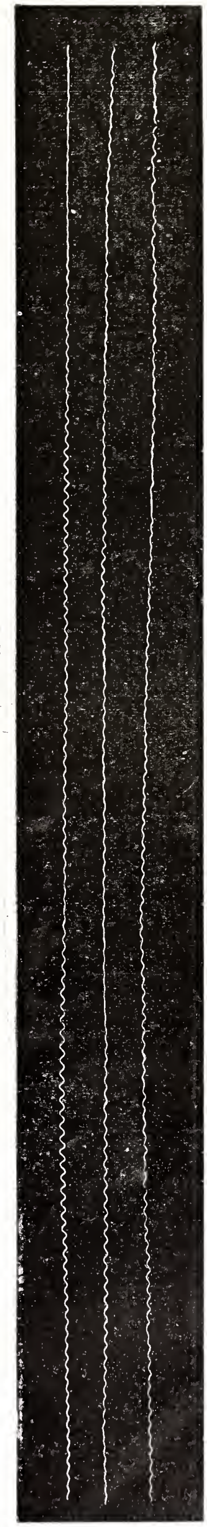
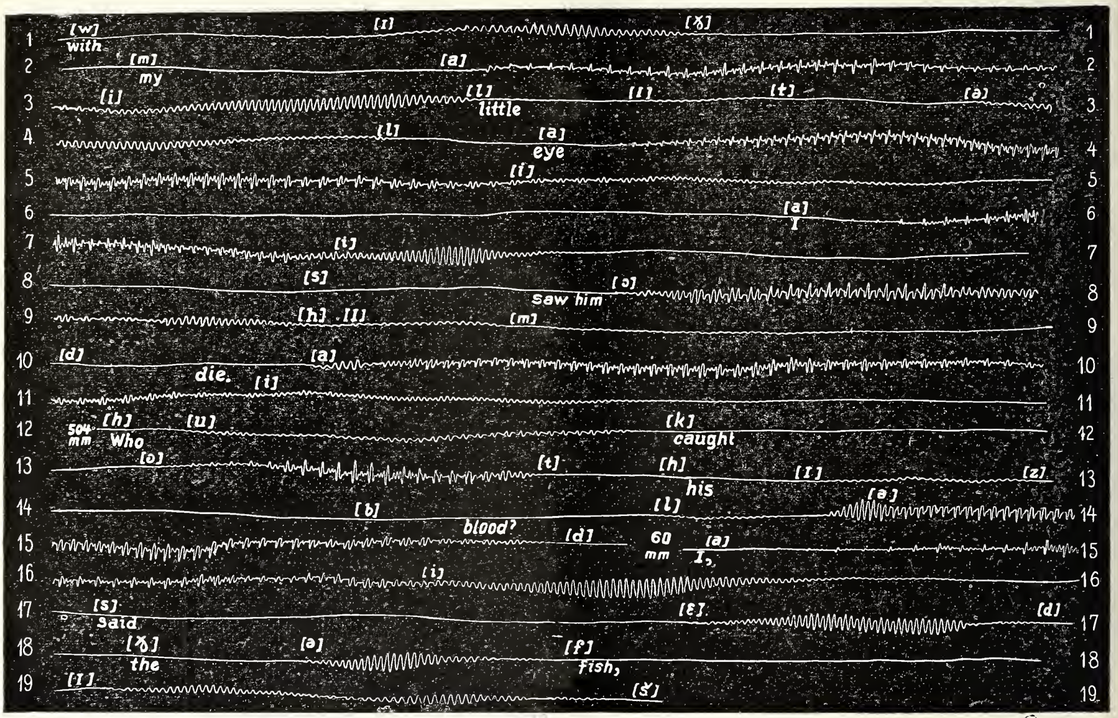


Fig. 20.

Tremolo: ·4 sec.

FIG. 21.



PART OF "COCK ROBIN": 6·5 sec.

the actual sound waves of a record being produced by means of a spot of light (reflected from a revolving mirror) tracing a curve during the playing of a record. The apparatus is one invented by Mr. G. Bowron.

During and after the reading of the paper a selection of records of orchestral effects and of songs sung by celebrated singers were rendered by the latest form of Gramophone and by the Auxeto-Gramophone.

DISCUSSION.

The CHAIRMAN (Sir William Preece) in proposing a hearty vote of thanks to the author for his interesting paper, said it was the custom of the Society to invite discussion on the papers read before it, but he was sure the audience would agree that the paper was such an excellent one, and had been so enchantingly illustrated, that there was nothing further to be said on the subject, except perhaps on the question of priority of patents, and so on, which could be better discussed in other places. He had had a long experience as a lecturer and speaker, but he did not think he had ever seen an illustration which gave more food for thought, than the connection between the sonorous vibrations of the music, and the vibrations of light, shown in the last experiment. They had heard, with their ears, certain musical sounds, and at the same time had seen, with their eyes, the vibrations following each other methodically and in scientific order. He wished to impress upon the audience that what they saw on the diagram were absolutely the corresponding movements that took place in the tympanum, a little organ of animal tissue inside the ear, about the size of a fourpenny piece, which had a beautifully delicate construction, almost beyond conception, reproducing every sound uttered. Through the sense of sight the vibrations were seen on the diagram, and through the sense of hearing the music was heard. From the retina of the eye and the diaphragm of the ear there was a kind of telegraphic movement of the nerves going on which conveyed the message to the brain, and produced there the conceptions which had been so vividly brought before them. His mind was carried back to Wednesday evening, May 8th, 1878, exactly 30 years ago, when he showed the phonograph in the theatre of the Society. His paper then was not accompanied by any music or experiments such as the author had shown, but he was able to speak on to a tin-foil plate, and impress on it sonorous vibrations to be uttered; and both the audience and himself were delighted to hear the reproduction. That was the first occasion on which the phonograph was shown to the Society.

The author had given a most interesting history of the evolution of the auxetophone. He dealt first of all with Edison's phonograph; secondly, with the graphophone of Tainter and Bell; thirdly, with the gramophone of Berliner, and finally, with the auxeto-gramophone of the Hon. Charles Parsons, to whom they were so much indebted for marine turbines. That evolution had occupied thirty years, but that was a common feature of the history of the introduction of any invention. First of all it was introduced as a toy, then as a scientific apparatus, then as a practical machine, and lastly as a source of industry. He wished the author had given some idea of the financial aspect of the question, for after being a plaything and a waster of money for about 25 years it had now become such a prosperous trade that it was a source of great wealth to the gentlemen connected with it.

The vote of thanks having been carried unanimously, Mr. Reddie briefly acknowledged the compliment, and the meeting terminated.

THE PORT OF ANTWERP AND RIVER QUAY BERTHS.

The report of Consul-General Sir Cecil Hertslet, on the shipping and navigation of the Port of Antwerp (Cd. 3727-51), has some opportune remarks upon the progress of the port and the demand for river quay berths. In 1905 the spaces allotted to vessels were rearranged, and most of the regular lines of steamers were given quay berths on the river, thus avoiding the necessity of their entering the docks and the loss of time therein entailed. During the past year complaints have been made by British shipowners that British ships have suffered from the want of adequate berthing arrangements, and the vessels have been denied the facilities afforded by the river quay berths with a view of their being forced into dock berths. It has also been alleged that whilst the Belgian Government is interested in the dues charged for river quay berths, the City of Antwerp is interested in dues charged for berths in dock, and, therefore, vessels are sent into the docks when berthing accommodation might have been found for them at the river quays. Sir Cecil Hertslet points out that of the total dues levied for the Antwerp quays, about three-fourths are received by the municipal authorities and about two-fifths by the State. While, therefore, the Municipality of Antwerp receives the whole of the dock dues, it has, at the same time, a greater interest than the State has in the quay dues. The actual river space now available for berthing accommodation is 6,012 yards, while the dock space available is 17,773 yards. Moreover, the upper portion of the river quay space has not a sufficient depth of water for large ocean-going steamers, and it has, therefore, been allotted to smaller steamers belonging to regular lines trading to the United Kingdom.

The fact is, as the Consul-General points out, that the demand for river quay space is much greater than the limited berthing accommodation on the river at the disposal of the Municipality, and that the river quay berths are already allotted to their utmost limits. It may be that what is the case at Antwerp would not necessarily apply at other great ports, but it is undeniable that berths on the river quays at Antwerp are much more sought after than the berths in the docks. It is not a question of expense to the ship, at any rate in the case of the lines, since the dues in their case are the same for dock as for river quay accommodation. The preference for river quays is due to their saving time and making the manœuvring of large vessels easier, and if there were more river quays at Antwerp they would at once be occupied. But Sir Cecil Hertslet points out that there are physical and political difficulties which prevent the extension of the river quay system at that port, for the present in any case, and the fact that the maritime extensions are so largely based on the dock system cannot be urged as a proof that the authorities of the port, or public opinion, are in favonr of the dock system to the detriment of river quay account.

Under a law passed in August last the Belgian Government is authorised to commence the works for the construction of the canal dock, and for the excavation of two of the nine subsidiary docks, authorised in 1906, for the extension of the Port of Antwerp. These docks will furnish an additional berthing accommodation of about 5,468 yards, for ships of the largest size, and are the commencement of the vast scheme of port extension (the question of the *Grande Compare* being reserved) accepted by the Belgian Parliament. The State undertakes the work, and provides the necessary funds, the reimbursement by the town of Antwerp of the capital expended by the State in this work being a matter for subsequent arrangement. The expenditure upon the port of Antwerp up to 1906 amounted to £8,928,000, of which sum, £4,320,000 was expended on river quays, and £4,608,000 on docks. The estimated future expenditure at given by the City Engineer to Sir Cecil Hertslet is £7,000,000 upon the port extension scheme, £4,400,000 upon the *Grande Compare* (in abeyance pending the decision as to the advisability of its construction) and £160,000 upon a new dry dock at Kruisschars, making a total of £11,560,000, and bringing up the past and estimated expenditure on the port of Antwerp to £20,488,000.

THE CANADIAN WOOD-PULP INDUSTRY.

Great interest is being manifested in British Columbia in a new company organised in Vancouver, owing to the fact that it will use the vast waste material from the saw and shingle mills, including the sawdust, which is now burned at some expense to prevent large accumulation. This com-

pany, according to the American Consul at Vancouver, first contemplated the establishment of its plant in the United States, but was forced to abandon that plan, because it was found that the supply of fresh water was insufficient. After a thorough investigation, it finally arranged for the purchase of 80 acres of land opposite Gambier Island on Howe Sound, twenty miles from Vancouver, at the entrance of Rainy River, where there is an abundant supply of water at all seasons. By utilising the water-power of the Rainy River, the company will develop sufficient water-power for mechanical and domestic use, and for a series of mechanical grinders for the manufacture of ground wood, which is used to supplement chemical fibre in the manufacture of paper. The plan is to convey the refuse of the local mills, of which there is said to be 3,000 tons in the vicinity, in specially-prepared scows to the plant, where the entire mass is to be disintegrated into suitable fineness for conversion into wood pulp. This will do away with the expense incident to the use of uniformly cut wood, which is said to be the only method now in general use by the paper mills throughout Eastern Canada and the United States. One of the innovations of the new company is a patented process whereby it can use Douglas fir and other resinous woods in the manufacture of wood pulp. Paper-makers in the past have never been able to use woods containing pitch and resin for paper purposes, owing to the difficulties in separating the cellulose from the pitch, resin, and essential oils; by the new process all these parts are passed off in vapour, and the fibre is recovered by subjecting the mass to a system of pressing. The company now have in operation in Vancouver, a complete, but small, plant for the manufacturing of pulp and paper, which fully demonstrates the process, and which is both ingenious and simple. The wood is first placed in what is known as a chipping machine, and reduced to small shavings, the shavings pass up a flume, and enter a digester which consists of a large perpendicular, copper-lined circular reservoir that ordinarily ranges from eight to twelve feet in diameter, and twenty-four to forty-eight feet in height. The digester is filled with a solution of caustic soda, and the entire mass of shavings, ranging from eight to ten tons, is thoroughly cooked under a high pressure of steam for several hours, until the cellulose is thoroughly released. The black mass is then removed to the draining floor or press, where the caustic soda is separated as much as possible from the fibre. The material then passes to the beating machine, which consists of a wooden or metal tub, ten to fifteen feet long, with round ends, on the centre of which is a partition called "midfeather." A roller is provided with knives, and it revolves over a bedplate of similar knives. The distance between the bedplate and the roller is regulated by a wheel and screw. The pulp, after it passes between the bedplate and the roller, flows down the backfall and around the "midfeather," back to the starting point. The machine is also provided with a washing cylinder, which is so made that, as it revolves, it scoops up the water which flows through its axis; the pulp is kept out by a fine wire gauze surrounding the cylinder. A large quantity of water is admitted into the heater, which is removed by the drum washer, and the pulp in this manner is rapidly cleansed. During the process of the beating, this pulp is coloured or bleached. The bleaching is accomplished by a solution of chloride of lime. After passing through the beating engine, the whole mass is run through a refining engine. This machine consists of a stationary hollow comb, mounted with knives on the inside, which fit over a solid rapidly-revolving comb, mounted with similar knives on the outside. The pulp passes between the combs, and the knives can be brought close together or separated with great accuracy, so that the degree of fineness of the pulp can be adjusted. The material is then run into what is known as a pulp pit, where it is taken up by large machines and run into merchantable paper of varying character and fineness. The plant, as outlined, will have a capacity of 360 tons of finished material per week. In addition to the local trade, the company proposes to enter the markets of Australia and New Zealand, Japan, and the Western United States.

THE MANCHURIAN FUR TRADE.

Mukden has for many years been one of the three most important centres of the fur trade in China. Its geographical situation in the centre of the three most northern fur-producing provinces, in former times the converging point of the chief cart roads of central Manchuria, and now the junction of four lines of railway, as well as its political and commercial importance as the seat of Manchurian government, and the largest city in population, have combined to make it such a centre. In addition to this geographical and political importance, which makes the city a market for general trade. Mukden provides one of the best tanning and curing establishments in the East. Raw skins brought there from the north are dressed and cured in the forty tanneries of Mukden, and in the local fur shops made ready, not only for the local trade, but also for shipment to Tientsin and Shanghai, the chief fur markets south of Manchuria. A large part of the local fur-dealing industry consists, after the skins are tanned and cured, in assembling them in shapes and sizes corresponding to the Chinese short outside jacket or long coat. In the work of thus matching and combining skins the Chinese are very clever. In winter, throughout the cold latitudes of China, the Chinese of all classes wear fur, wool, or hair-lined garments. Even the labourers have their sheep or goat skins, and people of the middle and official classes have many sets of garments lined with the richest furs. In China, houses are rarely heated to the winter temperatures of European or American interiors, and in consequence, fur-lined clothes are worn indoors as well as out. Accordingly there is annually an

enormous demand in Mukden for furs actually used by the native population, or marketed by local retailers over the province. As a distributing centre for the fur trade, Mukden, according to the American Consul-General, is also important. Large shipments are made every winter to Shanghai, *viâ* Newchwang, and smaller shipments to Tientsin, which depends chiefly for its supplies upon Mongolian fur districts. Buyers from the southern ports occasionally come to Mukden, but the chief trade is carried on either through agencies at the ports, or by sale direct to the retailers there. Several Mukden fur dealers have expressed a desire to deal directly with foreign agents, but although buyers of European fur houses come now to Tientsin and Shanghai, none as yet have tried to reach Mukden markets direct. The furs sold on the Mukden market come chiefly from the more northern provinces of Kirin and Heilungchiang; of these there are more than ten different kinds. Tiger, leopard, wolf, white fox, and mountain badger come from Heilungchiang; yellow fox, grey squirrel, and other small species of animals from Sansing, Heilampo, and Ninguta, in the province of Kirin. The province of Shenking, or Fengtien, of which Mukden is the capital, produces only mountain goat, deer, sheep, dog, and one or two other kinds of skins. Cat and dog skins are used extensively, and the latter are valued highly enough to justify the establishment at various places in the province, of dog farms. From Mongolia come cow and sheep-skins. Practically all of these furs and skins are imported into Mukden in the raw state, and are tanned locally. Manchurian furs are, by general consent, of excellent quality. Tiger skins are much larger than the Bengal or Amoy pelts, and on account of the more northern territory in which the animal is found the fur is thicker and deeper. Sportsmen, who know the tiger of South China and India, say that the Manchurian variety is the finest beast of his species in the world. Leopard skins are also unusually large and heavily furred. Fox skins compare favourably with the best Canadian varieties, particularly silver fox, and the higher grade Manchurian sables equal the best Russian sables. Goat-skins from this region are plentiful and cheap, and make excellent rugs, or cheap skin coats. It may be said in general of the Mukden and Manchurian fur trade, that although it is very large, it might well be much larger, and from a foreign point of view, more mutually satisfactory to producer and consumer were it freed from certain restrictions under which it now labours. The first of these restrictions is the inflation in all prices which the Russians have left as a legacy to other buyers in the Manchurian markets. The Chinese have not yet recovered from the impression gained prior to and during the first part of the war, that a price, however disproportionate to the cost of production, competition, or supply, might be exacted of buyers in the open market. From the Russians the Chinese asked, and got, more than double the rates they can now obtain from the Japanese. Furthermore, the confusion and uncertainty in the currency leads invariably to an advance in prices. In Mukden four mediums of exchange—the Japanese gold yen, the silver yen of the Yokohama Specie Bank, Mexican dollars, and the local (Fengtien) currency, circulate with constantly varying values. In addition to Russian influence and uncertain currency the Chinese custom in sales and barter, namely, the absence in dealing with foreign buyers of anything in the nature of fixed prices determined by natural conditions of trade, the tradition of prolonging a sale beyond the limits of modern expeditious business methods by the insistence upon prices largely in excess of those finally to be accepted with a fair margin of profit, still further restrict what should be a steady growth in a trade which already constitutes a large part of the winter industry of the people throughout the north-eastern provinces of China. Opportunities for foreign buyers are therefore only good in case fur houses can send representatives to North China to familiarize themselves with the situation in Chinese markets. Such men by following the markets in the chief centres—Mukden, Tientsin, Newchwang, and Kwangchengtzu—might, it is said, be able to establish a very profitable trade in Manchurian furs and skins.

NAGPUR EXHIBITION, 1908.

It is proposed to hold at Nagpur, in November next, an Exhibition of the products and manufactures of the Central Provinces and Berar, which will remain open for about six weeks.

The Bengal Chamber of Commerce has circulated the following memorandum on the Exhibition, by Mr. C. E. Low, C.S. of the Industrial Survey, Central Provinces:—

"The possibilities of the Central Provinces as a field for industrial enterprise have hitherto been too much neglected by Calcutta firms, with the result that Bombay has shared to a far larger extent in the recent commercial development of that area. The importance of Nagpur as a cotton field is well known. The area under that crop last year was nearly five million acres; there are hundreds of gins and presses which employ a number of engines of about 40 or 50 horse-power and upwards. Much difficulty is experienced in finding skilled engineers, and a simple type of oil engine would be sure to sell. Local capitalists are, nowadays, investing largely in gins, and many of them will visit the Exhibition. There are four or five spinning and weaving mills of fair size in or near Nagpur, as well as the Empress Mills of Messrs. Tata. Messrs. Petit are just taking over and restarting on a large scale another mill. The Empress Mills are already partly run by electricity. A scheme for electric lighting in Nagpur city is on foot, and, in any case, electric lighting for the Government offices cannot be long delayed. Some large irrigation schemes are coming on very shortly, which will neces-

sitate the employment of a good deal of engineering material of a general type. Local agriculturists would be interested in pumping apparatus, small oil engines, reapers, hand-baling presses, and agricultural machinery of a suitable type. The Agricultural Department, who sell a yearly increasing number of such machines, will supply more detailed information of the kind of article that is required. A good deal of fibre is exported from Jubbulpore and other stations, and a good hand-baler would be thoroughly appreciated.

"The importance of the Central Provinces as a mining field has been a good deal before the public of late, and there is a good local demand for mining machinery, such as picks, shovels, rails and wagons, wire and other ropes and mechanical drills. For mineral and other traffic, light railways or other forms of transport would attract a good deal of attention. Light portable forges and other general engineering goods, pipes, carts, and other contractor's goods, might advantageously be shown. The principal classes of purchasers would be found among local mill-owners and mining companies, Government departments, and representatives of firms visiting Nagpur from all over India. Besides these a special effort is being made to get in as many as possible of the local agriculturists, for whose benefit the Exhibition is largely intended. Not less than two lakhs of rupees will be spent on the Exhibition, and Government have lent the services of an officer on special duty to assist in organising it."

PICTURE POST-CARDS.

At a recent meeting of the German Geographical Society the idea was advanced, for the first time, to employ picture post-cards as means of instruction in the schools. The post-card industry has made enormous progress in the last few years, and in the last few months cards have been brought into the market, illustrative of natural history, political history, and for use in instruction in the German language, which have met with the hearty approval of professors and teachers of repute. According to the American Consul at Magdeburg, the school museum at Breslau has undertaken to form a collection of these cards, and for this purpose the authorities have requested the various publishers to forward them samples of their output, that it may be determined to what extent they may be used for purposes of instruction. Further, two teachers in Leipzig, have established a central bureau for post-cards of all sorts, intended for purposes of instruction or collection. They have also developed, and offered for sale, two practical systems for the display and filing of the cards. These gentlemen select and arrange the cards most carefully, according to pedagogical principles. Such prominent educationalists as Harms, Tischendorf, Rudolf Schmidt, and others, have endorsed the plan of using illustrated cards as an aid in instruction, and even official bodies anticipate favourable results from them.

ARTS AND CRAFTS.

Some Recent Embroidery.—The banner which Mrs. Louis Davis has worked for presentation to Earl Grey, Governor-General of Canada, and which has been on view in Grafton-street during the month of April, is one of the most interesting pieces of embroidery which has been shown for some time past. The subject, Saint George and the Dragon, has been treated with fancy and ingenuity by Mr. Louis Davis, who is responsible for the design. The Saint stands upright in the centre of the banner, sword in hand, trampling on the folds of a large snake-like dragon lying on the green grass—on his left arm he bears his shield, and in his right hand grasps his sword. Behind him blooms a rose bush - and scattered on the white field, at well chosen intervals are five little emblems in exquisitely delicate colour. The colour scheme of the whole has been well thought out—the pale reddish pink of the roses above the head of the figure leads to the crimson cross of his shield—and the theme is carried still further in the deep and varied purple of the huge coils of the creature at his feet. The armour is goldish in colour, and the sword extraordinarily steely in effect—though it is embroidered almost entirely in silks—and the only metal introduced is an outline of fine aluminium thread round the edge. The only part of the whole composition which is carried out in gold thread is the nimbus of the Saint, which is executed entirely in couched gold and forms a great contrast to the rest of the work. The details of the mounting have been very carefully thought out, and prove how much more important proper mounting is than a good many workers seem to suppose. The pearly grey and white fringe which finishes the base of the banner was epecially made for it and is in thorough harmony with the general colour scheme, while the slight border so delicate in colour as to be almost lost as design, tells happily as texture, and the silken cords and tassels (made by the way by Mr. Louis Davis) are quite unlike the heavy accessories which too often disfigure otherwise beautiful banners. The needlework is very interesting. It is quite obviously the work of a more or less self-taught workwoman who has simply done what seemed good in her own eyes without any very conscious reference to the conventional way of doing things, and the result in this case is decidedly satisfactory. No doubt the work might in places have been with advantage more technically perfect, but the general effect is not only quite good but remakably fresh and vigorous. A worker who has not been trained in the ordinary mill is too often incompetent—when she is not, her want of training, though it must in some ways hamper her, may sometimes be more than counterbalanced by the freshness and individuality of her work.

A large proportion of the embroidery being shown at the New Gallery has been seen in London before. There is, however, a fair amount of pictorial work on view—the best of it by Miss Button—and work

of a more ornamental kind is exhibited by Miss Newill and Miss May Morris.

Silversmith's Work.—There has been within comparatively recent years a great revival in artistic silversmith's work, but this has been, in the main, due to artists who, like Mr. Wilson, Mr. Nelson Dawson, and others, have turned silversmiths, and who either execute their work themselves, or get it carried out in their own workshops. In comparison, little has been done by artists working with or for trade firms. The casket just presented, along with the honorary freedom of the borough of Preston, to Mr. John Forshaw, is a striking instance of what can be accomplished by an artist who will take the trouble to work with the trade. It has been designed and modelled by Miss F. H. Steele, who has had it carried out, under her careful supervision, by Messrs. Plante and Bannister. The box is oblong in shape, and has two figures (representing, in one case, Justice and Learning, and, in the other, Shipping and Spinning—the industries of Preston) on each of its sides. The figures are, as it were, backed by ornamental strapwork, and are connected by a band of small, ornamental ships in very low relief, while from the bosses at the two ends hang handles similar in shape to the ornament framing the figures. There is a broadish band of lettering silver on a background of beautifully variegated dull turquoise enamel, running round the top of the casket; and enamel is introduced again in the arms of the town of Preston, which decorate the middle of the front. The work is characterised by that rather severe dignity of design which we are accustomed to look for in Miss Steele's work, and should rank as one of her most successful productions. The little figures are charming both in conception and execution, and the restraint and sense of proportion in the ornament, as a whole, are all that could be desired. That the refinement and general excellence of the workmanship are in part due to the careful direction of the artist, there can be no doubt, but the success of the venture proves at least the possibility of getting a thoroughly good result when work designed by an accomplished and practical artist is carried out under her direct guidance by thoroughly competent trade workers. This point is still further proved by Miss Steele's exhibit at the New Gallery. This, like many of the other exhibits, consists largely of work which has already been exhibited elsewhere, but this is the first time that the various works have been shown together, and they certainly form a very satisfactory little show. In a few cases, such as the tall, graceful trophy and the beautiful little figure group presented to the Duchess of Bedford, only casts or models are shown, but the triptych presented to Lord Derby by the town of Preston, produced by Messrs. Barkentin and Krall, and the yacht club cup, rose bowl, &c., lent by Messrs. Elkington, all go to prove that, if good work is often produced by the artist craftsman working on his own account, a no less happy result can be attained by a practical artist who will take the trouble to see that his designs are adequately carried out by trade workmen.

GENERAL NOTES.

Cotton Growing in the West Indies.—It is pleasant to note the growth of the cotton industry in the West Indies. In a memorandum on the culture, improvement, and diseases of Sea Island cotton, just issued by the United States Department of Agriculture, there is the following, on the development of the West Indian Sea Island cotton industry:—"Sea Island cotton, produced in the West Indies, is equal to the average American product, and indeed competes with the Carolina Sea Island cotton rather than with the interior product. The West Indian industry is new, having been developed mainly since 1902, and is yet of small proportions. Only about 4,000 bales per annum are at present produced; but the industry there may grow rapidly. It has already led the South Carolina planters to organise in refusing to sell seed. The Sea Island grower will therefore recognise that the prices of his crop depend on several factors, and that quality is more important than quantity. Organised efforts should be made to raise the standard of length and preparation, in order to avoid competition with cheaper cotton. Of the better grades a larger quantity can be sold than is now produced."

Invisible Exports.—In reviewing the Brazilian export trade, Mr. Consul Casement (Cd. 3727-35) refers to one aspect of it which does not come within the field of published export trade statistics. It may be termed "invisible exports." It offers an interesting study for those having financial interests in Brazil. Very large payments are made locally to foreign workers—natives of Italy, Spain, and Portugal—who come in many thousands to Santos and the interior of San Paulo to work the coffee plantations or engage in other highly-remunerative manual tasks connected with the coffee trade. The vast majorities of these labourers return ultimately to their native countries, and take with them in their belongings large accumulations of gold coin. They also purchase very largely, during their stay in Brazil, bank drafts to cover remittances to their friends at home. No account is taken in Brazilian commercial statistics of these "invisible exports." That they constitute a steady export of the wealth of the country is certain; how great a drain it would be impossible to say. In 1904, £789,000 in gold coin alone, exclusive of other specie, was imported by Brazil, and in 1905 this import had risen to £2,852,000. The published export figures for these two years are only £8,900 in 1904, and £10,731 in 1905. Thus against an import of £3,646,000 of gold coin in these two years there is

a recognised export of less than £20,000, leaving a balance of £3,626,000 unaccounted for. That this balance was not in circulation in the country, is, says Mr. Consul Casement, clear. Gold is never seen in use, and only a wholly insignificant circulation of silver coin even exists. The great bulk of this money, certainly over £3,000,000, left the country again in the pockets and bundles of returning European emigrants, and if to this large sum be added the very large remittances made by these people (purchased from the banks in Brazilian currency just as the gold coin is procured by the same medium), it will be seen that the "invisible export" of Brazilian profits amounts to a considerable annual sum.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

May 13.—"The Underground Water Supplies of the Thames Basin." By Clayton Beadle. Sir Richard Melvill Beachcroft, Chairman of the Metropolitan Water Board, will preside.

May 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. Martin Duncan.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

May 21.—"The United Provinces of Agra and Oudh." By Sir James Digges La Touche, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces. Sir William Lee-Warner, K.C.S.I., will preside.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 11...Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Cuthbert J. Lake, "The Licensing Bill, 1908."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Noel E. Buxton, "Geographical Conditions and Railway Construction in the Balkan Peninsula."

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Tuesday, May 12...Asiatic, 22, Albemarle-street, W., 3 p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. T. Trouton, "Why Light is Believed to be a Vibration."

Faraday Society, 92, Victoria-street, S.W., 8 p.m. 1. Dr. F. Mollwo Perkin, "Industrial Uses of Ozone, particularly for the Purification o Water." 2. Messrs. L. O'Dowd and F. Mollwo Perkin, "Determination of Boiling Points of very small Quantities of Liquids." 3. Mr. V. H. Veley, "Apparatus for the Determination of the Dielectric Constants of Non-conducting Liquids."

Photographic, 66, Russell-square, W.C., 8 p.m. Address by Mr. Furley Lewis, at Opening of One Man Exhibition.

Zoological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Mr. T. A. Coghlan, "The Prospects and Possibilities of Irrigation in Australia."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m. Mr. O. D. Mackenzie, "Gardening in the West Highlands."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Annual Meeting.

Junior Institute of Engineers, United Service Institution, Whitehall, S.W., 8 p.m. Mr. F. R. Durham, "The Design of a Sewer."

Wednesday, May 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Clayton Beadle, "The Underground Water Supplies of the Thames Basin."

Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

South African Colonisation Society, Claridge's Hotel, Brook-street, W., 4¾ p.m. Annual Meeting.

Japan Society, 20, Hanover-square, W., 8½ p.m., Dr. W. L. Hildburgh, "Japan Household Magic."

East India Association, Westminster Palace Hotel, S.W., 4 p.m. Mr. C. E. D. Black, "The Trade and Resources of Tibet."

Thursday, May 14...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m. Annual Meeting. 1. Mr. A. Lamberton, "Improvements in Plate Rolling Mills." 2. Mr. James E. York, "The Physical Qualities of Steel in Relation to its Mechanical Treatment." 3. Dr. T. E. Stanton, "A New Fatigue Test for Iron and Steel." 4. Professor B. Igewsky, "An Experimental Electric Furnace for the Smelting of Iron."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Bateson, "Mendelion Heredity." (Lecture III.)

Junior Art-Workers' Guild, Clifford's Inn, Fleet-street, E.C., 8 p.m. Mr. H. J. L. Massé, "Pewter."

Electrical Engineers (at the House of the Royal Society of Arts), John-street, Adelphi, W.C., 8 p.m. Dr. C. C. Garrard, "Switch Gear Control Apparatus and Relays for Alternating-Current Circuits."

Mathematical, 22, Albemarle-street, W., 5½ p.m.

Friday, May 15...African Society, Criterion, Piccadilly, W., 8½ p.m. Address by Sir Percy Girouard.

Royal Institution, Albemarle-street, W., 9 p.m. Dr. H. T. Bulstrode, "The Past and Future of Tuberculosis."

Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m. Annual Meeting continued. 1. Mr. F. J. R. Carulla, "Cast Iron in the Construction of Chemical Plant." 2. Mr. E. F. Law, "The Application of Colour Photography to Metallography." 3. Mr. C. von Schwartz, "The Utilisation of Blast-Furnace Slag for Portland Cement." 4. Mr. W. Rosenhain, "The Department of Metallurgical Chemistry in the National Physical Laboratory." 5. "Mr. J. Wesley Lambert, "The Pyrometric Installation of the Ordnance Factories, Woolwich."

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Paper on "Mantegna."

North-East Coast Institute of Engineers and Ship-builders, Newcastle-on-Tyne, 7½ p.m. Discussions on—1. Prof. R. L. Weighton's paper, "Piston Speed and Steam Engine Economy." 2. Mr. E. Hall Craggs' paper, "The Framing of Ships."

Saturday, May 16...Royal Institution, Albemarle-street, W. 3 p.m. Mr. L. Binyon, "Japanese Prints." (Lecture I.)

Journal of the Royal Society of Arts

No. 2,895. VOL. LVI.

FRIDAY, MAY 15, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, MAY 20, 8 p.m. (Ordinary Meeting.) F. MARTIN DUNCAN, "Industrial Entomology: or the Economic Importance of a Study of Insect Life."

THURSDAY, MAY 21, 4.30 p.m. (Indian Section.) SIR JAMES DIGGES LA TOUCHE, K.C.S.I., "The United Provinces of Agra and Oudh."

CONVERSAZIONE.

The Society's Conversazione this year will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Thursday evening, the 2nd July, from 9 to 12 p.m.

The programme of arrangements will be announced in future numbers of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 13, 1908; SIR RICHARD MELVILL BEACHCROFT, Chairman of the Metropolitan Water Board, in the chair.

The following candidates were proposed for election as members of the Society:—

Dunn, Hon. George Owen William, M.Inst.C.E., Bombay City Improvement Trust, Bombay, India.
Headlam, Rev. Arthur Cayley, D.D., King's College, Strand, W.C.
Nishizuka, Toyosaburo, President, Korea Oil Company, Seoul, Korea.

The following candidates were balloted for and duly elected members of the Society:—

Azizuddin Hussain, Khan Bahadur Mahammad, Collector and District Magistrate, South Canara, Madras, India.
Cunningham, P. A., R.I.M. Dockyard Extension, Bombay, India.
Din, Hon. Mian Mohd. Shah, B.A., Lahore, Punjab, India.
Goto, Baron S., President, South Manchurian Railway, Tokio, Japan.
Greaves-Walker, Arthur F., Utah Fire Clay Company, 1098 South First West-street, Salt Lake City, Utah, U.S.A.
Hart, Sidney George, Shillong, Assam, India.
Hughes, Hon. John, M.L.C., Vice-President of the Executive Council, Sydney, N.S.W., Australia.
Hughes, Right Hon. Thomas, Lord Mayor of Sydney, Sydney, N.S.W., Australia.
Kenyon, James, Walshaw Hall, Bury, Lancashire.
Larmour, Hon. Charles Frederick, care of Smith's Shipping Agency, 18, Eldon-street, E.C., and 60, Bentinck-street, Calcutta, India.
Parshad, Lala Joti, K.I.H., Jagadhari, District Ambala, Punjab, India.
Saklatvala, Shapurji D., 2, Norfolk-street, Strand, W.C.
Scotland, Thomas McIntosh, Tollcross, near Glasgow.
Shakespear, Lieut.-Col. John, C.I.E., D.S.O., 20, The Barons, St. Margaret's, Twickenham.
Slater, Edward Murray, Red House, Woodbridge, Suffolk.
Watkins, Arthur Anderson, A.M.Inst.C.E., Bala Lodge, Blackheath, S.E.

The CHAIRMAN, in introducing the reader of the paper, said that it was through the initiation of Mr. Clayton Beadle, who was a Kent man, that the Underground Water Preservation Society, of which he was the Secretary, was formed; he was a member of the Royal Meteorological Society and a Fellow of the Chemical Society; and there was no one better able to give an instructive paper on the subject.

The paper read was—

SOME OBSERVATIONS UPON THE UNDERGROUND WATER SUPPLIES TO THE THAMES BASIN.

By Clayton Beadle.

My limited knowledge and experience would make it impossible for me to go into the subject of this paper in a general way, dealing with its many aspects, and moreover a task such as this even to those of wide experience, would be an extremely difficult one. There already exists considerable literature devoted to the subject of underground waters, more particularly that of the Thames Basin.

It would be as well, perhaps, to explain my reasons for having given so much time to this work. My attention was first drawn to the subject of water supplies on account of my connection with the paper industry. This industry depends essentially upon a copious and abundant supply of water. Of late years paper mills, in common with others, have been severely handicapped by the increased difficulties which they have experienced in obtaining their necessary supplies.

I obtained returns from all parts of the country of the amount of water consumed in the manufacture of different kinds of paper during the different stages of manufacture.* To give some idea of this, I would state that the production of paper in this country is about 800,000 to 1,000,000 tons per annum, and the amount of water required varies from 10,000 gallons to 200,000 gallons per ton of paper manufactured. Some of the leading mills which were established more than 100 years ago were situated on streams from whence they got their water-power and the water used in the manufacture of the paper from wells. There are about 60 paper mills in the Thames Basin, for the most part producing that class of paper which requires the use of large quantities of water. Now, many of them have to compete for water against large pumping stations in their own water-bearing areas.

I have returns of the water pumped for nearly every paper mill in the London Basin, and I had hopes of obtaining returns of all industries, but the task is a very large one, and for the time being I have contented myself with the paper industry. But for every paper mill there may be a dozen or more breweries and many other industries which cannot exist unless they can still obtain the necessary supplies. I can vouch for the fact that, with the increased difficulty of obtaining water, the mills have gone to considerable trouble and expense to economise water as far as possible, much of it being carefully purified and used over and over again.

* Chapter on Paper Making. Vol. iv., pp. 80-99.

No attempt will be made to review any aspect of this vast subject as affecting the whole of the Thames Basin, as my statistics are not sufficiently complete, and it would be work entirely beyond my resources. The chief points which I wish to emphasise are questions of depletion as judged by the amount of water taken from a given area within the basin in comparison with the probable amount that the said area is by common consent supposed to yield. The area chosen is that known as the Kent Water Works Company's area. It is chosen merely because I have sufficiently complete information of the total amount of water pumped, which, as far as I know, cannot be said of any other area within the Thames Basin. On the subject of infiltration from the Thames, the writer has accumulated data with the co-operation of many of the firms who have works in the low-lying lands on both sides of the river between London and Gravesend. The information is most complete for the southern side, particularly that portion within the area above mentioned. The opinions expressed by the firms in question show remarkable uniformity on the subject of infiltration, so that a general consensus of opinion can readily be arrived at. I have, however, sought for confirmatory evidence by making observations of my own on different lines to those furnished by the manufacturers.

The subject of the paper may, perhaps, be conveniently divided up under the following headings :—

(1) Visible depletion.

(2) Available supplies.

(3) To what extent supplies have been drawn upon.

(4) Future supplies and requirements.

Depletion.

As to visible depletion in a general sense as affecting the Basin as a whole, I do not think I need labour this point, as so much has already been written upon this subject. I attempted to summarise evidence of this nature in a short communication to the Sanitary Congress, July 9th, 1903 (see Appendix). Although there may be differences of opinion in regard to the extent of depletion, the fact that serious depletion exists is now generally admitted. I mention this because

up to about five years ago there were many who persistently argued that the then shortage in streams and reduction of levels was only of a temporary nature and the result of dry seasons. I do not think further need be said about general and permanent depletion in the home counties.

Coming now to the question of depletion of the district under review, this also is a matter of history which needs only brief reference. In a paper before the Sanitary Congress in 1901, I pointed out that the then deficiency of rainfall could not be made to account for the drying up of certain streams within the district, and my arguments were strengthened by the fact that a previous and similar drought had not brought about the same state of affairs that then existed. These views were strongly contested by one of the directors of the Kent Water Company, who sought to prove that the deficiency of rainfall was the chief factor in the loss of water to the streams. In order to get a general expression of opinion from people in the district, a meeting was called at Cannon-street Hotel. The meeting not only endorsed these views, but went so far as to form an association for the protection of their interests. This association, known as the Underground Water Preservation Association, in addition to opposing Bills before Parliament, made it its business to collect information bearing on the subject of depletion. I mention this as evidence of serious depletion within this district. I do not, however, purpose to pursue the work of the association further, as further information on this subject can be sought elsewhere.

In 1901, I was able to cite an extreme case of the drying up of a stream that had ceased to flow only within the previous few years; prior to which it had been a copious stream for centuries. There was something better than measurements of flow to prove this, namely, the fact that there were a number of mills taking their water-power in abundance from the stream, now no longer able to receive sufficient water to turn the wheels around. The stream at its source was formerly provided with copious springs, the volume of which was known, and within a short distance from the source a mill received ample power. On the establishment of a pumping-station at a point above the source, which would naturally intercept water that would otherwise reach the spring, the springs gradually diminished until they practically ceased altogether, when it was found that the water pumped at the pumping-station approximately equalled the average amount of water which before the establishment of the pumping station reached the springs. The conclusion appeared to be irresistible, namely that the main cause of the drying-up of the stream was the pumping. I cite this merely as a case in point; there are others of a somewhat similar nature.

At times statements have appeared in the daily Press of a sensational and alarming nature. The Press would have us believe that the end of all things is at hand as regards our sources of water supply. Although I would not presume to prophesy what the future has in store, I am bold enough to say that behind all these wild statements there is an element of truth.

I speak of depletion as visible depletion, by which I mean that which is evident to the casual observer. The total amount of depletion, visible and invisible, could only be measured by records taken over a period of years such as by a series of records of measurements, of flow of springs, streams, and well-levels. I would, therefore, regard visible depletion as that removal of water which manifestly affects the interest of water users, riparian owners, and others, and visibly affects the flow of streams, &c.

Available Supplies.

It is of primary importance to distinguish between supplies available and supplies obtainable. It may be possible for many years to come to sink new wells, or deepen existing wells, and obtain greatly increased supplies for the time being, even in districts where there is already a shortage, but, of course, this could only be done at the expense of the future, or at other people's expense. The same point arises with regard to forestation. The removal of underground water at a greater rate than the same can be restored by the rainfall results, of course, in depletion. Springs and streams may be the first to disappear. It is questionable whether available supplies should include that water which, if removed, would result in loss to streams and springs. I raise this point, not in its legal aspect, but from the point of view of—say the finding of Lord Balfour's Commission. As to the legal aspects, I cannot do better than refer lay readers to Messrs. Graham and Bidder's recent paper, before the Surveyors' Institute.*

* "Underground Water," by Messrs. W. Vaux Graham, M.Inst.C.E., and Harold F. Bidder, "Transactions of Surveyors' Institute," vol. xxxix., part 9, April 8th, 1907.

The recent investigations of Baldwin-Wiseman tend to throw new light upon the subject of the motion of sub-surfaced water.* Elsewhere I have referred to many of the early publications on this and allied subjects.

Up to a few years ago, the supplies available and the supplies, for the time being, obtainable, appeared to be regarded as one and the same thing. Now, however, the fact is becoming somewhat more recognised that only such water should be taken as can be taken in perpetuity without affecting already established interests, and therefore in any finding as to available supplies over any district, I claim that this broad principle should be borne in mind. Now depletion is very much marked, the available supplies are already too much drawn up on in many districts.

The question, therefore, resolves itself into a consideration of how far the available supplies have been exceeded and how far they are likely to be exceeded in years to come if the increased pumping of the future is to be judged by what has taken place in the past. Is the available supply of a district to be judged by the amount of water that percolates? I have had under observation the results of daily readings of eleven percolation gauges, some of them extending over a considerable period, and have attempted to summarise percolation figures given by different observers.† Many difficulties present themselves in arriving at a definite figure over any given areas. Allowances have to be provided for in various directions. To put the percolation at so many inches for any given district such as that under review is but to hazard a guess. The permeability of the soil must vary enormously at different points, and the district may be contributing to the underground waters of other districts or be receiving contributions from them either from surface beds or underground sources. But assuming that a definite figure could be established such as, say, ten inches of water precolating per annum, what proportion of this is available by pumping?

Of that which percolates a great deal leaks away to the bed of the river Thames, and that which is pumped has to be caught on its passage to the Thames. Of course that which leaks to the Thames is diminished by the pumping. It is not a reservoir but an underground river, for ever changing in its higher reaches in its levels and rate of flow.

Although there are many uncertainties, one can or ought to be able to establish a maximum figure. Thus, it might be said that the available supplies over the district are something less than 8 inches for an average year out of a rainfall of 27 inches, and not more than 4 inches during a dry year. I would consider 10 inches to be a figure for the water obtainable for the time being rather than for water available for future supplies.* Even if 10 inches percolate, we cannot guarantee that the whole can be raised by pumping. If we adhere to the figures of 110 square miles as the area, we should have 44,000,000 gallons per day for 10 inches of percolation. Had we accepted the suggested figure of 7 inches, we should have only 30,800,000 gallons per diem obtainable.

Infiltration from Thames.

In any computations such as those given in evidence before the Royal Commissions for water available to the water companies for water supply, little or no account seems to have been taken of the liability of infiltration from the River Thames in the event of the low-lying land being drawn upon.

I prepared a statement of evidence collected with the object of ascertaining the probable effect of maintaining the water of the Thames permanently at high-water mark upon the low-lying land in its neighbourhood.†

This might bear brief reference in so far as the question of infiltration is likely to affect the available supplies to users of water in the low-lying lands.

The Thames walls below London, although built of clay and watertight in themselves, are raised upon marsh land which in many places is pervious to water. In many parts of the marshes the level of the water in the wells corresponds approximately with the mean tide level.

In the Appendix will be found notes on the various tidal wells which were not included in the publication above referred to (Table L). We noted at the time the condition of many of these tidal wells; they are found to rise and fall with the rise and fall of the tide, either corresponding with the tide or lagging behind

* "Influence of Pressure and Porosity on the Motion of Sub-surface Water." Quar. Journ. Geol. Soc., vol. lxiii., 1907, pp. 80-105.

† "Journal of the Sanitary Institute," vol. xxiii., p. 4.

* Reckoning as usual that 1 inch of annual rainfall percolating is equal to a discharge of 40,000 gallons a day per square mile.

† "The Port of London." Swan, Sonnenschein and Co. p. 81-100.

the tide according as to whether the percolation from the Thames is free or sluggish, and depending to some extent on the distance of the well from the river. Furthermore, some of these wells are found to be very brackish as the result of ingress of river water, some of them being more brackish at the high level than at the low. (See Table K.)

In one notable case large quantities of water are pumped from the ballast to a distance of 200 feet from the river, the water being practically the same composition as the river water, proving the rapid ingress of water from the river to the point at which the pumping is conducted; at such points comparatively slight depression of levels due to pumping will result in a rapid and ready percolation.

The lower reaches of the Thames are in many places exposed to the bare chalk or to other permeable strata. Water pumped from the chalk in the low-lying lands, even when shielded for the first 100 feet, is found in places to draw large quantities of river water.

Evidence was given before the Balfour and other Commissions,* as to the large bodies of water actually seen issuing from the bed of the river in the form of springs, in such neighbourhoods as Erith, and those familiar like myself with such districts were acquainted with their appearance. Probably on account of the increased pumping, these springs are much less seen than formerly, but they indicate, in the writer's opinion, a direct communication between the river Thames and the underground water in the chalk. By the aid of subsoil maps of the lower Thames Valley, one has further evidence of the liability of infiltration.

Evidence before the Royal Commission appears, however, to disregard the liability to infiltration from the Thames, which, under existing conditions, make this source of supply useless for drinking purposes, especially as infiltration increases through depression of levels by increased pumping. Several schemes have been put forward for obtaining large quantities of water close to the river Thames for the supply of London. At many of the works which we visited on the low-lying lands we found that the well water had been condemned for drinking purposes on account of its brackishness, although copious supplies could be obtained for manufacturing purposes; in other places great trouble resulted in steam raising in consequence of the brackishness of the water. It is to be presumed that this low-lying land is no longer seriously considered as a possible source of supply to the metropolis on account of its proximity to the Thames.

In order to form some idea of the permeability of the alluvium river and valley drift in this low-lying land, I took particulars of 154 trial borings, and classified the surface deposits under five headings in ascending order of permeability. From a series of tables I arrived at a permeability of 40 per cent. in comparison with freely permeable beds.

The amount of percolation to wells was roughly computed in many cases by determining the salt in the water of the well and comparing the same with the mean brackishness of the water in the river Thames in the vicinity of each well. The latter was arrived at by curves of saltness from data from Professor Way's analyses.

Table J is of some assistance in forming opinion on the subject of percolation, and is constructed with assistance of Mr. Whitaker's "Chalk Area Maps."

Table K shows the results so obtained of 13 wells which show a percolation of 5 to 25 per cent. of river water.

Within the area of the Kent Water Company in 1903-4 at least 2 to 3 million gallons per diem of water was percolating from the river to the wells. It seems probable, therefore, that at least 10,000,000 gallons per diem of river water was and still is reaching the various wells at the present time situated on the low-lying lands in the neighbourhood of the Thames. The conclusion appears to be, that with increased pumping on these low-lying lands increased percolation will result, and consequently an increased proportion of brackish or river water will find its way into the wells, so that there need be no dearth of water in the low-lying lands, but the water will be of no service for drinking purposes, and, on account of its increased brakishness, of less service for industrial purposes as time goes on. This conclusion is what one might expect from the fact that a large part of the lower Thames flows over permeable beds, which beds communicate inland to low-lying marshes, and the scour of the tide keeps these permeable beds from becoming pugged by the deposition of river mud.

The marsh land has been much improved by drainage of late years, many important factories have sprung up, and it contains a very large population. This drainage can

* Mr. Barlow's evidence before the Duke of Richmond's Commission, 1869, sections 76 and 77. The Report of Lord Balfour's Commission, 1893, section 97.

be accomplished so long as we have low water at every tide. The suggestion to maintain the level of the river at high water-mark from this point of view alone presents almost insurmountable difficulties. If it were not for the difficulties of flooding the land, the percolating waters from the Thames would tend to make up for the water taken from the wells and the percolating water would be fresh, but whether contaminated or not it is difficult to say.

My conclusion as to the suggestion for a barrage, although outside the question we have under discussion, appears to me irresistible, namely, that in view of the fact that much of the low-lying land in the neighbourhood of the Thames is below high water-mark, and that the saturation level is approximately equal to that of the mean tide level, and also that the levels fluctuate slightly with the tide; if the water of the Thames was permanently held up to high tide level, this low-lying land would be submerged by the infiltration of river water—under but not through the bank. And the infiltration in places, at least, might be so rapid as to make draining the marsh land a very difficult engineering problem.

Amount of Water Pumped.

Evidence has been entirely lacking in the various districts of the home counties as to the amount of water that is pumped, because private concerns are very wary in letting the public know what amount of water they are using; but with local assistance I was able to obtain figures for all the pumping within an area formally administered by the Kent Water Company. This is the only area of which I have sufficient returns. In this area there are about 80 industrial concerns, &c., which derive their water supply from wells. These consist of breweries, paper mills, engineering works, chemical works, public baths, cement works, wharves, electrical engineering works, municipal undertakings, asylums, flour mills, &c., in addition to wells used for pumping water for public supplies.

Where possible the figure taken is not the figure taken for one day's measurement, but an average figure throughout the year. In many works with the aid of the engineers and managers a very close figure was obtainable. In other cases the amount of water can only roughly be computed. Many of the firms in question expressed their willingness for me to make known the amount of water which they used and have used from time to time. But in as much as in many cases I was permitted to take the returns provided that I did not disclose the names of the firms in question, provided also that the figures were taken in conjunction with other figures used for forming general conclusions, I have in the Appendix omitted the names of the firms in question and merely substituted a number. (Tables A to F).

The returns have been taken with the object of discovering what was the probable amount pumped by private concerns at the time of Lord Balfour's Commission, and what the amount ten years after. For purposes of convenience the returns are divided under various headings, the first being that portion of the area that is within the County of London, the second that portion of the area that is situated along the Thames river side and low-lying lands below the County of London. The first may be regarded as a purely arbitrary division; the second is of importance from the fact that the firms in question derived their supplies from the low-lying lands in the neighbourhood of the Thames, and a good deal of the water which reaches them is the result of infiltration from the Thames, rendering much of the water in this district brackish and unfit for drinking purposes in many cases. We have the analysis of the water from different works, much of which is of a very pure character where derived from high ground. The third part gives returns from the river Darenth; the fourth from the watershed of the river Cray; the fifth that part of the Darenth situated outside the part of the water company's area; and the sixth the amount of water pumped from that portion of the area which is situated in the area of the Gravesend Water Company. From these are constructed summaries (see Tables G and H).

The water pumped by various industries, &c., is far greater than is generally supposed. The figures given in Tables A, B, C, D, E and F, represent the amount of water pumped by various industries during the year 1903. The "lower limit" shows the quantities when the weekly average is comparatively high. When the figures in the two columns correspond, it may be assumed that there is little or no variation. The 1893 figure is got from general information such as is given in wide column.

The aggregate amount pumped is without

doubt greater than that shown under the lower limit on Tables A to F, and probably not so great as that shown under the higher limit. The actual figures may be regarded as between the two.

As a portion of the watershed of the Darenth reaches outside the district of the Kent Water Company, the amount of water pumped in this district is shown under Table E, amounting to about 204,000 gallons a day, and the amount of water pumped in the Gravesend district, adjoining the Kent Water Company, is shown in Table F, amounting in the aggregate to upwards of 882,000 gallons per day.

The present large amount of water pumped by industries, &c. (upwards of 22,000,000 or 23,000,000 per day) probably stood at about half this figure at the time of Lord Balfour's commission.

Tables A to F give information supplied by the various firms from which the increases since 1893 have been computed, but in order not to overestimate this increase it is computed on the basis of the lower limit, and there is every reason to believe that the actual increase is in a greater ratio than that stated. Where no information is at present available the supply has been regarded as stationary, although in many cases considerable increase may have taken place.

Out of the 80 firms there are only two or three cases where a decrease has taken place.

In arriving at the above figures a deduction had to be made in some cases :—

(1.) For infiltration of river water (calculated from analysis of water pumped as compared with a mean analysis of nearest river water), and

(2.) For soakage back into the soil, as in the case of brick and cement makers.

The figures so deducted make up in all upwards of three millions of gallons per diem, about two-thirds of which consist of Thames water which has soaked through bed of river and found its way into the wells.

Therefore the total amount pumped may be accounted for as follows :—

	Gallons.
Infiltration from Thames	2,000,000
Water pumped and allowed to soak back into land	1,000,000
Water pumped and permanently removed (Table G)..........	22,000,000
Total	25,000,000

The population of the Kent Water area shows an increase of about 20 per cent. during the ten years, the increase in population in the industrial centres having advanced very largely at the expense of the agricultural.

The agricultural districts adjoining the industrial centres have actually declined in rateable value whereas the chief industrial centres have advanced between 50 and 60 per cent.

The leading factories, &c., pumping large quantities of water advanced in the aggregate during the ten years by 67·4 per cent. in net rateable value. These figures were arrived at by constructing tables of returns for such districts.

There has been a great development within this area during the last twenty years, as this district offers great facilities for establishing industries. The great bulk of the industries at the present time are dependent upon abundant supplies of water. If these supplies should fail, these industries would be crippled, with disastrous consequences to the people living in this area.

In arriving at this safe limit, *i.e.*, 27,500,000, it would appear that Lord Balfour's Commission could have had no knowledge of the large amount of water even then pumped by the various industrial concerns, for it is stated (paragraph 131 of Report "Kent wells") "from the south side of the river no evidence was submitted in favour of the Kent Company in respect either of their present take of water, or of their proposals in the future."

When the amount pumped for 1903 by the Kent Water Company is added to that of the manufacturers, the total amount of water pumped within the area of the Kent Water Works Company is not less than 40,000,000 gallons per diem, as follows :—Lower limit, 22,000,000. Total average pumped by the Kent Water Works Company, 18,000,000. This is far in excess of the safe limit of 27,500,000 as stated by Lord Balfour's Commission.

Can the rate of increase in pumping for industrial work in the future be judged from the rate of increase during the ten years under review ? The increase in rateable value is not in a similar proportion to the increase in rate of pumping. The pumping represents an increase of 100 per cent. on the figures of 1893. If the same *rate* of increase should take place during the next ten years (*i.e.*, doubling in ten years), we should have no less a quantity than 44,000,000 gallons pumped per day in the year 1913 for industries, &c. But since the figures have been compiled, pumping in

the low-lying lands for the purpose of reaching the chalk has ceased. This somewhat releases the stress for the time being in its neighbourhood, and would modify our views as to future requirements.

There is still, however, indication of rapid increase. If we take the same *aggregate* increase, this would give for the manufacturers, &c., for the year 1917, 36,000,000 gallons, or, say, upwards of 1,000,000 gallons per diem additional for every year.

If to the above be added the requirements of water for public supply for future years within the area, which we may call for 1917, 25,000,000 gallons, over 60,000,000 gallons per annum for the district for 1917. Such a quantity must be far and away above what can be restored to underground supplies from the rainfall, so that it is evident that sooner or later we shall have to face a check in our industrial development as well as a curtailment in the amount of water that can be drawn from these areas.

General Observations and Conclusions.

It is quite impossible to ascertain the proportion that the area, under observation, bears to the whole of the Thames Basin, from the point of view of water pumped. But the total number of wells in the whole Basin might easily be twenty times, and the total amount of water pumped, from underground supplies, five to ten times. It is, however, quite idle to speculate on this point. One thing, however, appears to be certain, namely, that the quantities pumped say, in the home counties particularly, in and around London, prove on closer inspection to be far greater than was generally supposed. Otherwise the Royal Commissions would, presumably, have taken them more into account when attempting some estimate for available future supplies. This question offers food for reflection to those responsible for future supplies of water to our vast metropolis.

We are much in the dark on the subject of underground water, largely because of the difficulty of obtaining authentic records. To judge of the available supplies, it is of the utmost importance that observations in regard to percolation, flow of streams, evaporation, water levels, and so forth, should be as complete and as well organised as are the collection and tabulation of rainfall statistics. This would involve much work.

In addition of course to the above-mentioned subjects being extended, there also arises the question of the total amount of water pumped from different areas and water-sheds, coupled with the question as to whether the quantities are on the increase or decrease. Unfortunately, however, many large users of water strongly resist any such movement, for fear that the figures that they might be called upon to furnish would be exploited for the benefit of others.

As is well known, percolation gauges have been in operation for a long period, and figures carefully recorded. Some of the results have from time to time been published. These gauges might with advantage be multiplied in different parts of the country. I made an attempt a few years ago to get the various agricultural colleges to take up the matter of percolation and well measurements. If it had not been for the vacations making a break in their records, some of them would have taken the work up.

I should like to take this opportunity of suggesting that some engineer might with advantage devote his attention to devising an automatic recorder for well levels, which could be left for months, or even a whole year, without attention. The relation between the rainfall and level of water in a well has formed the special study of two members of our Association.* For this purpose, it is important to find wells out of the influence of pumping operations, which is not always an easy matter. It is anticipated that further publications will shortly appear on the subject.

It might, perhaps, be here mentioned, that recently a blow was given to what is known as the "Roving Clause." It appears that it will no longer be permitted for wells for public supply to be sunk on ground not got for the purpose. This recent decision of the Courts seems a fair one. I understand that Parliament has also come to a like conclusion. A company having acquired land in the above manner can, of course, go to Parliament for power to use the land for the purpose.

Perhaps on no subject is there greater diversity of opinion among experts than on underground waters; this is evident from reading evidence give before Royal Commissions. All appear to be agreed, however, that it is a subject on which some special enquiry should be held.

On October 29th, 1902, a deputation consist-

* "The Relation of Rainfall to the Depth of Water in a Well," by Dr. Charles P. Hooker, Royal Meteorological Society, *Journal*, Vol. xxix., No. 128.

ing of County Councils' Association, the Sanitary Institute, the British Association of Waterworks Engineers, and the Underground Water Preservation Association, presented a deputation to the President of the Local Government Board (the Right Hon. Walter Hume Long, M.P.). Mr. Heywood Johnstone, who introduced the deputation, stated that the following memorandum had been adopted, namely, respectfully to call the attention of the Secretary of the Local Government Board to the question of the protection of sources of water supply in England and Wales, and to the pressing necessity for an enquiry into the existing state of the law on the subject. In so doing they proceed on the assumption, firstly, that the question is one of great and increasing importance to the community at large; and, secondly, that the laws governing it are defective and faulty. Furthermore, he stated as to the existing state of the law there is no protection for the underground water which cannot be proved to flow in some definite and known channel.

Mr. Long, in reply to the deputation, referred to the Royal Commission then sitting to enquire into the pollution from sewage. Mr. Long gave the deputation to understand that before he could hold out any hopes he would like some expression of opinion from the Royal Commission.

Since that date no progress has been made in the matter, and I am now unofficially informed that the same bodies who formed the deputation in 1902 desire again to approach the Secretary of the Local Government Board. In view of the proposal to introduce a Bill to carry out the recommendations of the Royal Commission on sewage disposal, an attempt will be made to call the attention of the President of the Local Government Board to the fact that this Commission took no evidence on the question of water supply *per se*, and that legislation on the subject would therefore be somewhat premature.

That the time has come to urge the desirability of a special and official enquiry into the question of water supply as distinct from that of sewage disposal and other sanitary matters, is, I think, sufficiently made out from information contained in this paper which I have much pleasure in bringing before the Society.

In conclusion, I wish to express my thanks to my associate, Dr. H. P. Stevens, for his valuable assistance in collecting and tabulating the records.

APPENDIXES.

Wells in the London Basin.

It has been estimated that there are as many as 1,500 private wells in the London Basin, but the average amount which they deliver per diem is not known. As 65 of these wells, sunk by a well-known engineer, show an available pumping capacity of about 10,000,000 gallons per diem, the aggregate amount pumped is probably much in excess of that pumped for purposes of public supply. In other quarters it has been estimated that there are 1,000 private wells in the London Basin lifting on an average 100,000 gallons each daily. This would give an aggregate of 100,000,000 gallons per diem.

Unofficial returns to me of the total water consumption per ton of manufactured product and the amount of output of certain of our manufactures, would suggest that our manufacturers are drawing enormous quantities of water from the London Basin, and that the above-mentioned estimate is by no means an exaggeration. In 1893, 172 chalk wells were estimated to yield about 10,000,000 gallons, and the number of wells were said to be greatly on the increase. In places where 100 years ago the water when tapped would rise to the surface and overflow, the level is now over 100 feet below Ordnance datum, and in some parts of London it is considerably lower. In 1850 the permanent levels were depressed from 50 feet to 60 feet at the lowest point; a depression had been noticed 30 years previously. In 1850 the level was falling at the rate of one foot per annum. In 1893 the fall was variously estimated as between 12 and 18 inches per annum.

List of Books and Reports.

1. Report issued by order of the House of Commons in 1828, on the Metropolitan Water Supply.

2. "The Periodical Alterations and Progressive Permanent Depression of the Chalk Water Level under London." Inst. of Civ. Eng. Vol. 9. 1850. Rev. James Clutterbuck, M.A.

3. Reports on the "Condition of the Metropolitan Water Supply," by the Water Examiner, appointed under the Metropolis Water Act, 1871.

4. Papers dealing with Rainfall and Percolation. Institution of Civil Engineers. Vol. 45, part 3; 1876. Symons, Greaves and Evans.

5. The Presidential Address to the Geological Society, by Sir John Evans, in 1876.

6. "Chalk Water System." Institution of Civil Engineers. Vol. 47, part i.; 1877. Joseph Lucas.

7. "Maps showing the Area of Chalk available for Water Supply in the London Basin." Read before the Sanitary Congress at Portsmouth, 1892. W. Whitaker, F.R.S.

8. Report on Lord Balfour's Commission, 1893.

9. Report on Lord Llandaff's Commission, 1899.

10. "The Lake under London as a Public Water Supply," 1900, by Walter Moseley.

11. "Guide to the Geology of London and the Neighbourhood." Memoirs of the Geological Survey, 1901. W. Whitaker, F.R.S.

12. Pamphlet issued by the Underground Water Preservation Association, 1902.

13. "The Scenery of England," by Lord Avebury. 1902.

14. Report on the "Shrinkage of the Thames and Lea," February 10th, 1903. Maurice Fitzmaurice, Chief Engineer to the London County Council.

15. Remarks by Sir Alexander Binnie at discussion at the Sanitary Institute on February 11th, 1903, on "The Present Shortage of Water available for Supply."

16. Articles on returns from different parts of the country of the amount of water in gallons per ton required for different qualities of paper. "Paper and Pulp." March and April, 1903. Clayton Beadle.

17. "The Relation of the Rainfall to the Depth of Water in a Well." May 20th, 1903. Dr. C. P. Hooker. Jour. Roy. Met. Soc. Vol. 29.

18. "Evidence as to the cause and effect of the lowering of the permanent water-levels in the London Basin." Clayton Beadle. *Journal of the Sanitary Institute*, vol. xxiv., Part III. July, 1903.

TABLES A TO K.

TABLE A.—*Amount of Water pumped from Wells by the various Industries, Institutions, &c., in that portion of the area of the Kent Water Works Company which is within the County of London.*

No.	Water pumped in gallons per diem during 1903. Lower limit.	Water pumped in gallons per diem during 1903. Higher limit.	Information supplied as to increase or decrease of water pumped since 1893.	Increase or decrease in gallons per diem since Lord Balfour's Commission in 1893, computed from foregoing figures and information.
1	10,000	11,000	No information	—
2	607,000	678,000	No information	—
3	35,000	35,000	Increase of 49,000	+ 49,000
4	26,000	26,000	Pumped more since 1896	—
5	10,000	10,000	New works; demand rapidly increasing	+ 10,000
6	280,000	280,000	Stationary	—
7	30,000	35,000	Stationary since 1881; anticipates sinking new wells	—
8	28,800	28,800	No information	—
9	30,000	60,000	No information	—
10	336,000	336,000	——	—
11	82,000	82,000	Started 1897; anticipate increase to 88,000	+ 82,000
12	92,000	92,000	Stationary for 40 years	—
13	11,400	11,400	Increased 33 per cent.	+ 2,800
14	7,700	7,700	Increase last two years of	+ 2,000
15	158,000	178,000	Large increase; 40 per cent.	+ 63,200
16	53,500	53,000	Demand stationary	—
17	100,000	100,000	New	+ 100,000
18	14,400	14,400	Large increase during last three years; probable future increase	+ 3,000
19	48,000	48,000	All new; 100 per cent. increase in near future	+ 48,000
20	21,000	21,000	No information	—
21	25,800	28,400	An increase of 30-50 per cent.	+ 6,400
	2,006,600	2,136,700		+ 366,400

TABLE B.—*Amount of Water pumped from Wells by the various Industries, Institutions, &c., in that portion of the area of the Kent Water Company which is situate along Thames riverside and lowlands below the County of London.*

No.	Water pumped in gallons per diem during 1903. Lower limit.	Water pumped in gallons per diem during 1903. Upper limit.	Information supplied as to increase or decrease of water pumped since 1893.	Increase + or decrease — in gallons per diem since Lord Balfour's Commission in 1893 computed from foregoing figures and information.
51			All new	+ 292,700
52	3,258,700	3,473,700	No information—but not largely increased	—
53			Increase of about 20 per cent.	+ 75,000
54			About stationary for last 3 or 4 years	—
55	85,500	94,000	No information	—
56	17,700	35,500	About stationary	—
57	1,004,000	1,004,000	About doubled	+ 502,000
58	1,570,000	1,570,000	No information	—
59	41,100	82,200	All new	+ 41,600
60	6,300	6,300	No information	—
60*a*	21,000	21,000	No information	+ 200,000
61	500,000	750,000	Greatly increased	—
61*a*	2,100	—	——	—
62	12,000	12,000	Stationary	—
63	17,000	17,000	All new	+ 17,000
64	36,000	36,000	All new, will shortly be doubled	+ 36,000
64*a*	10,300	10,300	No information	—
64*b*	11,400	12,900	Probably much under estimated	—
64*c*	7,100	7,100	No information	—
64*d*	42,800	42,800	Increase three fold	+ 28,600
64*e*	7,100	7,100	Increasing 100 per cent.	+ 3.500
22	342,000	342,000	Started since 1893	+ 342,000
23	90,000	100,000	Started two years ago; rapid increase	+ 90,000
24			About doubled	
25			Increase	
26			Started 1896	
27	9,106,500	9,106,500	All new	+ 8,791,700
28			No information	
29			Stationary	
	16,188,600	16,740,400		10,420,100

TABLE C.—*Amount of Water pumped from Wells by the various Industries, Institutions, &c., in that portion of the area of the Kent Water Works Company which is situate in the Watershed of the Cray.*

No.	Water pumped in gallons per diem during 1903. Lower limit.	Water pumped in gallons per diem during 1903. Higher limit.	Information supplied as to increase or decrease of water pumped since 1893.	Increase + or decrease— in gallons per diem since Lord Balfour's Commission since 1893, computed from figures and foregoing information.
30	28,500	28,500	More than doubled	+ 14,200
31	40,000	50,000	Probably decreased	—
32	864,000	1,080,000	About stationary	—
33	3,000	3,000	No information	—
34	617,100	740,500	Increased 50 – 100 per cent.	+ 205,000
35	30,100	30,100	Probably doubled	+ 15,000
36	4.300	8,600	Increase about 20 per cent.	+ 700
36*a*	92,000	92,000	All new	+ 92,000
	1,679,000	2,032,700		+ 326,900

TABLE D.—*Amount of Water pumped from Wells by the various Industries, Institutions, &c., in that portion of the area of the Kent Water Company which is situate in the Water Shed of the River Darenth.*

No.	Water pumped in gallons per diam during 1903.		Information supplied as to increase or decrease of water pumped since 1893.	Increase + or decrease— in gallons per diem since Lord Balfour's Commission in 1893, computed from foregoing figures and information.
	Lower limit.	Higher limit.		
38	150,000	175,000	No information	—
39	100,000	120,000	About doubled	50,000
40	583,000	583,000	Doubled	+ 291,000
41	145,000	145,000	About stationary	—
42	66,000	72,000	Considerable increase	—
42a	8,000	10,000	——	—
43	4,000	5,000	All new	+ 4,000
44	650,000	690,000	Greatly increased	—
45	22,800	22,800	All new	+ 22,800
46	21,000	21,000	No information	—
47	12,000	20,000	No information	—
48	104,500	104,500	Probably stationary	—
49	5,100	5,100	No information	—
50	50,000	60,000	No information	—
50c	257,000	257,000	More than treble	+ 171,300
50b	110,000	110,000	No information	—
50a	26,500	26,500	No information	—
50b	4,000	4,000	No information	—
50c	1,000	1,000	No information	—
	2,319,900	2,431,900		539,100

TABLE E.—*Amount of Water pumped from Wells by the various Industries, Institutions, &c., in that portion of the watershed of the Darenth which is outside the area of the Kent Water Works Company.*

No.	Water pumped in gallons per diem during 1903.		Information supplied as to increase or decrease of water pumped since 1893.	Increase + or decrease — in gallons per diem since Lord Balfour's Commission in 1893, computed from foregoing figures and information.
	Lower limit.	Higher limit.		
65	175,000	175,000	Considerable increase	+ 8,200
66	18,000	18,000	Decreased from 36,000 to 18,000	— 18,000
67	1,400	1,400	Increase about 10 per cent.	+ 100
68	10,000	10,000	All new	+ 10,000
	204,400	204,400		+ 300

TABLE F.—*Amount of Water pumped from Wells by the various Industries, Institutions, &c., in the area of supply of the Gravesend Water Company, and bordering on the north-east boundary of the area of the Kent Water Works Company.*

No.	Water pumped in gallons per diem during 1903.		Information supplied as to increase or decrease of water pumped since 1893.	Increase + or decrease — in gallons per diem since Lord Balfour's Commission in 1893, computed from foregoing figures and information.
	Lower limit.	Higher limit.		
69	800,000	1,200,000	Increase 10 to 20 per cent.	+ 80,000
70	7,000	7,000	No information	—
71	10,000	10,000	All new	+ 10,000
72	20,000	20,000	No information	—
73	1,400	1,400	No information	—
74	44,000	44,000	No information	—
	882,400	1,282,400		+ 90,000

TABLE G.—*Summary showing the ascertained totals of Water pumped in gallons per diem in the various districts within the area of the Kent Water Works Company for the year* 1903.

District.	Lower limit.		Higher limit.
A. L.C.C. Area	2,006,600	..	2,136,700
B. Riverside and lowlands	16,188,600	..	16,740,400
C. Cray Valley..	1,679,000	..	2,032,700
D. Darenth Valley	2,319,900	..	2,431,900
Total ..	22,194,100	..	23,341,700
E. Sevenoaks district ..	204,400	..	204,400
F. Gravesend district ..	882,400	..	1,282,400

TABLE H.—*Summary showing the ascertained increase in Water pumped by the various Industries, Institutions, &c., in the district within the area of the Kent Water Works Company.*

A. L.C.C. Area	366,400
B. Riverside and lowlands	10,420,100
C. Cray Valley..	326,900
D. Darenth Valley	539,100
	11,652,500
E. Sevenoaks district	300
F. Gravesend district	90,000
Ascertained pumping for 1903, say ..	22,000,000
Ascertained increase since 1893, say ..	11,000,000

TABLE J.—*Areas of Permeable, Impermeable and Mixed Beds in relation to Percolation to and from Chalk.*

Areas as Indicated in Mr. Hennell's Map.	Area below H.W.M. sq. miles.	Contributing Drainage Area sq. miles.	Below H.W.M. Permeable.	Below H.W.M. Mixed.	Below H.W.M. Impermeable.	Above H.W.M. Permeable.	Above H.W.M. Mixed.	Above H.W.M. Impermeable.
South Side of Thames—								
1. Swanscombe Marshes	·5	..	..	·5	..	..	..	
2. Dartford and Stone Marshes	1·8	10·0	..	1·8	..	8	1·0	1·0
3. Between Cray and Darenth	·3	·5	·1	·2	..	·5	..	
4. Crayford Marshes	·6	2·0	..	0·6	..	1	1·0	
5. Erith Marshes, &c.	2 6	6·0	·1	2·5	..	1·3	3·9	·8
6. Plumstead Marshes	2·3	..	..	2·3	..	..	..	
7. Greenwich Marshes	1·1	2·5	..	1·1	..	·8	1·7	
South Side Totals	9·2	21·0	·2	9·0	..	11·6	7·6	1·8
North Side of Thames—								
8. Little Thurrock and Grays Marshes	·9	..	..	·9	..	..	..	
9. West Thurrock	1·4	5·0	..	1·4	..	7·0	2·5	40·5
10. Rainham, Wenington and Avelly Marshes ..	3·4	..	..	3·4	..	..	..	
11. Barking Level, Ripple Level and Dagenham and Hornchurch	4·3	3·8	..	..	4·3	..	..	38.0
12. W. Ham, E. Ham, Plaistow Marsh and N. Woolwich Marsh	5·5	·6	..	1·7	3·8	..	·6	5·4
North Side Totals	15·5	9·4	..	7·4	8·1	7·0	3·1	83·9

SUMMARISED FROM TABLE J.

South side—

Below H.W.M... Permeable ..	·2 uncertain.
,, .. Mixed ..	9·0
,, .. Impermeable ..	nil

North side—

Below H.W.M... Permeable ..	uncertain.
,, .. Mixed ..	7·4
,, .. Impermeable ..	8·1

South side—

Above H.W.M... Permeable ..	11·6
,, .. Mixed ..	7·6
,, .. Impermeable..	1·8

North side—

Below H.W.M... Permeable ..	7·0
,, .. Mixed ..	3·1
,, .. Impermeable ..	83·9

Table K.

The following Table gives a few instances of infiltration of Thames water into large wells used by industrial concerns, arrived at by comparing the composition of the well water, with that of the nearest Thames water :—

Saltness in Grains of Chlorine per Gallon.

Location of well.	Well water. Grains per gallon.	Mean for river water. Grains per gallon.	Proportion of Thames water in well water pumped.
New Cross	90	50 to 500	say 25 p.c.
Charlton	29	100 ,, 700	,, 7 ,,
Woolwich	37	150 ,, 800	,, 7 ,,
Erith Marshes (1)	250 to 1,000	250 ,, 1,000	nearly all rain water.
,, ,, (2)	175	250 ,, 1,000	say 25 p.c.
,, ,, (3)	40	250 ,, 1,000	,, 6 ,,
Northfleet (1)	175 to 250	700 ,, 1,400	,, 15 ,,
,, (2)	34	700 ,, 1,400	,, 5 ,,
Dartford			,, 5 ,,
Purfleet	102	300 ,, 1,200	,, 12 ,,
Northfleet......	175	700 ,, 1,411	,, 16 ,,
Charlton	32	200 ,, 500	,, 8 ,,
New Cross	54	100 ,, 400	,, 10 ,,

L.—Notes as to Tidal Wells.

* In a well at the Thames Haven cattle loading station on the marshes, about 50 feet from the river bank, with water at a depth of 274 feet, the level ebbed and flowed with the tide, six inches above and six inches below the marsh level.

Well about 200 yards South of Erith Pier, ebbed and flowed with the tide; containing double the amount of salt at high, as compared with that of low level.

The cement manufacturers, Messrs. I. C. Johnson and Co., inform me that their wells at Greenhithe rise and fall with the tide.

A well which I have taken note of at Southwark rises and fall with the tide.

* The water-level of a well at Blackwall Trinity Wharf varied 2 feet with the tide, the usual level being about 13 feet below surface. Ground and ground level, 3 feet 9 inches O.D.

* At the Northfleet Town Cement Works the water level was $14\frac{1}{2}$ feet at low tide, and 6 feet 4 inches at high tide.

I have note of certain ditches below Erith which fill and empty with the rise and fall of the tide.

Mr. Thomas Hennell informs me that the water in a pit, adjoining Lonsdale-road, Barnes, rises and falls 6 feet with the tide; this pit is 200 feet from the river; and that the water in a pit at Lower Richmond-road, Mortlake, 1,200 feet from the river, rises and falls 4 feet.

Recorded cases of water entering wells from the river are worthy of note :—

A well sunk for hospital ships at Crayford Ness yielded very brackish water, and had to be abandoned.

* Mentioned in "Memoirs of Geological Survey."

Water pumped from the pit of the Northfleet Coal and Ballast Company was found to be brackish, and the brackishness increased with the reduction of levels; the amount of river water entering amounting to over 1,000,000 gallons per diem out of a total of 7,000,000 per diem pumped.

In most districts where chalk touches the river some brackish wells are to be found.

In a case recorded in the "Memoirs of the Geological Survey," on boring to 150 feet, water was found comparatively free from organic matter, but containing salt. The tubes were driven deeper and the boring continued, but the next sample yielded three to four times as much salt as the last. Above 130 feet the water was fresh.

In the case of a well brought to my notice at Gravesend, the well in question gave out in 1902, up to which time the water was very pure, and had no trace of brackishness. The well was deepened to a depth of 175 feet, at which a very copious supply of water was obtained, but it was so brackish that it could not be used in a laundry for washing purposes.

DISCUSSION.

The Chairman (Sir R. M. Beachcroft), in opening the discussion, said the question of underground water had become a matter of increasing interest, because so many consumers in London, particularly in the City, were talking of sinking artesian wells, in order to avoid what they considered were the iniquitous charges of the Metropolitan Water Board. Without offering apology for that Board, he would remind those present that when the great duty of supplying London with water was passed on to the Water Board, five years ago, the enormous sum of $47\frac{3}{4}$ millions was saddled on its back by way of payment for the undertakings of the eight water companies, and therefore, to some extent, the Board had a claim to something in the way of a monopoly, even with regard to underground water. The advantage of underground water was its purity, which was primarily due to the beneficial effect of filtration, and, secondarily, to the prolonged storage it undergoes in Nature's great underground reservoirs. The Water Board's treatment is just the reverse; they primarily stored the water long enough to make it innocuous, and then passed it through sand filters, in order to make it both palatable and clear. Every water authority and student of the subject was anxious to know something more about the history of underground water. They knew that it all originated in rainfall, but they did not know how the rainfall in the London Basin got through the impermeable clay. Although he had followed the paper closely, he was still in some doubt as to how that rainfall through the river, or otherwise, reached the wells through the impermeable clay; in other words, at what points the river found access to the permeable strata. He had been most struck by the remarkable statement

that, in the area of about 110 square miles of the late Kent Company, now the Water Board, the pumping undertaken on behalf of the various industries represented no less than 23 million gallons a day; and that if the 18 million gallons a day which were pumped for domestic purposes were added, a total of $40\frac{3}{4}$ million gallons was reached, whereas Lord Balfour's report in 1903 advised that $27\frac{1}{2}$ million gallons was the limit which could be drawn from the wells in that area. He understood from Mr. Clayton Beadle that, out of a rainfall of 27 inches, not more than 7 or 8 inches percolated, and if that was the case, taking the area of 110 square miles, the yield would be something over 30 million gallons, or 10 million gallons less than the amount now being pumped, which seemed to him to represent a very serious state of affairs. If that was the case, it would not do to regard the wells in Kent as reliable to any large extent in the future. Those interested in the question wished to know what was the effect of pumping, how long the supply could be depended upon, and to some extent also what was the risk of pollution. He should have been glad if the author had gone a step farther in dealing with the question of pollution. He quite understood his observations with regard to the percolation of water from the Thames and the possible risk of getting the wrong water in from that source, but he had always felt that the question of deep wells and the risk of pollution was one which could not be wholly ignored. because those who drank deep well-water took no precautions such as were used with regard to river-water. It was not passed through sand filtration, but drunk exactly as it was brought to the surface. Some people might think that the greater part of the water supply of London came from wells. So far as the Metropolitan Water Board was concerned, $78\frac{1}{2}$ per cent. of all the water supplied to the seven million people in greater London came from the Thames or its tributary, the Lea, and only $21\frac{1}{2}$ per cent. from wells and springs. It was impossible to tell what might happen in the future, and the Board might have to rely more on underground water. It, therefore, became of the greatest possible moment that they should know what likelihood there was of underground water being relied upon to a larger extent than it was at present, and what the effect of pumping was upon the rivers and springs. He entirely agreed with the concluding paragraph of the paper. A scramble for water was going on all over England, and unless some superior body stepped in and prescribed what sources should be allotted to particular districts, it might happen that the time would come when all the sources of supply had been "grabbed," and sufficient sources not left for those who required them.

Mr. Leon Gaster thought the question of water pollution was a most important one. He had recently heard more than one paper on the bacteriological treatment of water in order to make it suitable for drinking purposes, but the methods employed were expensive. When he was in Philadelphia last year he saw a large experimental plant shown by the United Water Improvement Company of Philadelphia, for treating very bad water, containing in the raw state as many as 2,000,000 bacteria per cubic centimetre, which were completely destroyed by the ozone process. Another process was now being used on a large scale by Siemens and Halske, and also by Lahmeyer and Co., while a plant had been installed at Nice which treated 5,000,000 gallons a day. The economy of the process was also very great, figures having been worked out which proved that for electric current the cost was only £16 to treat 22,000 gallons of very bad water a day, a quantity sufficient for a population of 1,000, with an average consumption of 22 gallons per head. Some apparatus are also made automatic, so that if it was not in working order the supply of water was cut off. It was sometimes suggested that if impure water was boiled it could be used for drinking purposes, but very few people would go to that trouble, especially as it was occasionally necessary to boil three times before the water became good for drinking. Other people suggested the use of filters in houses, which were satisfactory to begin with, but subsequently were a source of trouble, the filters becoming so saturated with bacteria that the water instead of being better, was worse after it had passed through it. Electro chemists are now working at a process which, it was hoped, would solve many difficulties. He desired to enquire whether the treatment of water by ozone, which satisfactorily destroyed all bacteria, was being experimented with in this country.

Dr. Edward Seaton agreed with the Chairman's remark that the paper might with advantage have been extended in the direction of the question of the possible pollution of underground water supplies. He was Medical Officer for the County of Surrey, which depended to a considerable extent for its supply of water on underground sources, and he had perforce given attention to the subject for many years. Fourteen or fifteen years ago a great agitation, having as its object the prevention of the establishment of an Isolation Hospital upon chalk downs, $2\frac{1}{2}$ miles away from a source of water supply, occurred. That seemed a long distance, but nevertheless there were a great many experts at that time who were prepared to come forward and say that it was a possible and appreciable source of danger. During the time to which he had referred the opinion of the medical profession had very considerably changed with regard to the water borne theory of infection in epidemic diseases. All medical men recognised that typhoid was the one water borne disease in England which had to be taken as the gauge of the possibility of danger. There might be others, but they could not recognise them at the present time as scientifically proved. It had also to be recognised that only a very small proportion of the typhoid fever

which prevailed in this country could by any proper reasoning process be attributed to water-borne infection; and though no doubt water-borne infection was still a potential source of danger, it bore only a small proportion to other possible sources of endemic and even epidemic prevalence. Medical men who have been connected with the public health service for many years remembered the days when the discussion was between the German view as advocated by Pettenkofer, and those who followed the teaching of the late Sir John Simon. In those days the belief was held that water-borne infection was, generally speaking, the way in which the preventible disease of typhoid was conveyed, but he thought it might safely be said that that was not the opinion at the present time. While saying that, he wished very strongly to emphasise the fact that there were certain very tangible dangers amongst them at the present moment. There were many towns situated like Worthing and Basingstoke, at which epidemics had occurred in the last few years, drawing their supplies of water from chalk right in the centre of inhabited districts; and while that state of things existed they could not afford to speak in any light way of the possibilities of water epidemics. Was it possible that the polluted water which was drawn from the Thames might give rise to epidemic disease? A very interesting paper had lately been given before the Epidemiological Section of the Royal Society of Medicine by Dr. Richards, of Croydon, and Dr. Brincker, in which they showed that under certain conditions, where there was in the chalk formation and certain other geological strata something analogous to swallow-holes existing underneath. These observations had proved that not only colouring matters, but harmless micro-organisms had passed a very great distance underground. He thought such investigations should engage the attention not only of Medical Officers of Health, but of all gentlemen who gave particular attention to the question of underground water supplies.

Dr. Beaton said that the Water Board had recently had considerable difficulty in one of the Kent wells of water percolating through into the well; and it was a problem whether the water came through from the river or from the marshes round about. A very large increase of eosin was found in the water, and as they pumped lower the eosin increased. The use of ozone had been under the consideration of the officials of the Water Board, but he did not think it had been employed yet. By means of storage and filtration, a very great deal had been done to obtain an excellent supply of water, not only from the deep wells in Kent, which were practically sterile from bacteria, but also in the 78 per cent. of water obtained from the Lea and the Thames. Sometimes the water in the Lea and Thames contained as many as ten thousand bacilli to the cubic centimetre, which were reduced after storage and filtration to 10 or 12. It was a question whether it was wise to get rid of all the bacteria, because it was now thought that some bacilli were friends, and that the only bacilli which should be destroyed were the pathogenic bacilli, which were their enemies. The type of friendly bacillus had not yet been discovered, but experiments from the negative side had been carried on in the Board's laboratory for nearly a year, and they hoped very soon to be able to tell the people of London that they had been enabled to find the bacillus of typhoid. In the examination of water, the cholera bacillus was looked for, which was a twin brother or sister to the typhoid bacillus, and came from the same habitat, the sewage. He agreed with the last speaker that there was not so much danger from water-borne disease, although the epidemics at Maidstone and Lincoln showed very clearly that water was one of the chief factors in the spread of typhoid fever. Not very long ago one of the members of the Water Board was fishing in a tributary of the Thames, and his supply of drink being exhausted, he took a drink of the stream running past, and as a consequence caught typhoid fever. The two bacilli most to be feared were typhoid and cholera. The Water Board, although it was a well despised body, was, considered in the light of other bodies, doing very excellent work, and its laboratory was as well equipped and managed as any laboratory in the world. One great question which had not been mentioned was whether water should be taken from the Thames and the Lea, when there were 1,250,000 people in the Thames Valley whose sewage went into the Thames, and 100,000 people whose sewage went into the Lea. A great risk was thereby run of the water being polluted. It had been suggested, as a solution of the question, that water should be obtained from Wales, and in all probability that would be done in the future, because the people of London would begin to realise that it would pay them to have an unpolluted water rather than run the risk of polluted water.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Clayton Beadle for his admirable paper.

Mr. Clayton Beadle, after thanking the audience for the kind way in which the vote of thanks had been passed, in replying to the discussion, said, with reference to the question of contamination, that until there was adequate protection of the water sheds which fed the underground sources of supply, there would be a liability or possibility of contamination of some of the sources of supply of the underground water which were now used for the purpose of public supply. It was a very remarkable thing that water which issued from the chalk in different districts remained so constant in regard to the mineral constituents it contained. That would lead one to suppose that the water travelled a very great distance before it issued out in the springs, and possibly it might go through such a distance of chalk that it prevented the likelihood of

contamination, unless it met with contaminated water somewhere near the point at which it was about to be discharged. Reference had been made to the use of eosin for detecting the travel of water. He believed either eosin or fluoresein could be detected in very minute quantities in water, especially by means of spectrum analysis, and consequently could be used as a means of testing the direction in which the water was travelling; but in some instances, at any rate, where water percolated through certain kinds of strata, the colour was removed from the water very readily; so that in regard to chalk or where the water was freely passing underground, eosin remained in the water, but under several circumstances it seemed to be very readily removed. In regard to the actual amount of water which was being removed from the district in question in comparison with what appeared to be the average percolation, nobody as yet could say with any degree of certainty what the percolation was and how much of it could be relied upon for the purpose of pumping, so that they were very much in the dark. It did appear, however, that what might be called a maximum figure might be established by means of percolation gauges, beyond which it would be impossible to obtain additional supplies of water without continually depleting the amount of underground water. It was very significant, however, that the amount of water which was being removed, when the records were taken, from this particular district, amounted to about 10 inches of water percolating per annum, this is a very high figure. He had only heard of the use of ozone for the purpose of purifying water, in connection with the water supply to Nice, where he understood it worked very well, and he was glad to hear what Mr. Gaster said about the economy of the process.

KHORASAN.

Khorasan is one of the places in Persia, the value of whose exports (precious stones, cotton, skins, wool, carpets, &c.) largely exceeds that of the imports, but owing to the difficulties of transport, it is not favourably placed for the development of Indian trade. For instance, in 1906, sugar prices ruled very high at Meshed, but a consignment sent from India was so long *en route* that on its arrival, several months later, the prices had fallen, and the sugar had to be disposed of at cost price. Wool and hides and other raw products of Khorasan are too bulky, and of too low a specific price to stand heavy transport charges. The consequence is that caravans from India or the Persian Gulf are compelled to return empty, thus doubling the transport charges on Indian goods. In the matter of tea, spices, and indigo, India manages to hold her own, though synthetic indigo continues to find favour in certain parts of Persia, owing to its low price and uniformity. The various routes by which British and Indian goods reach Khorasan are all very long and tedious, varying from fifty days (Bombay to Batoum) to 180 to 220 days from Trebizond *viâ* Tabriz and Tehran. For parcels up to 11 lbs. in weight the parcel post is incomparably the quickest mode of transit, this being by way of Askabad, and working out to 6¼d. per lb., while the time occupied to Meshed is about five weeks. Persian shopkeepers are beginning to utilise this route for watches especially, and if only there were suitable agents, much trade might be done in this direction.

Under present conditions, the bulk of the trade of Khorasan, both imports and exports, is done with Russia, and the advance in imports from that country during 1906, more especially in sugar and petroleum, was remarkable, tea showing a decline, owing to the disturbed state of the land routes from China. Similarly, in regard to tea exported to Russia, there was a decline owing to the Batoum route having superseded that *viâ* Bunda Abbas for green tea. But all other exports increased, viz., carpets, cotton, dried fruits, wool, and shawls. To Afghanistan sugar and cotton tissues are the chief exports, while practically the only product received from that country is wool. A rather odd product from this part of Persia is an edible earth, the chief constituent of which, on analysis, proves to be silica. It has found favour with the people for many centuries both as a food and a medicine. Lastly, mention may be made of an interesting fact reported by correspondents from the same region, *i.e.*, that a lucrative trade in Indian curios could be opened up with Russia. The Volunteer Fleet could provide cheap transit between Colombo and Odessa, which is close to Yalta, the Riviera of the country. Russians are struck with admiration for even the more common Indian art products, and it is believed that the opportunity would well repay attention and possibly lead to larger and more general trade between the two countries.

SARDINE FISHING.

The sardine fishing off the coast at St. Nazaire has been very bad, and to remedy this state of affairs St. Nazaire firms engaged in sardine packing have established branches at Tangier (Morocco), on which coast the fish is plentiful and exactly the same quality as the sardine previously fished off the coasts of Brittany and Vendée. They have their own packers, generally Breton people, and use their own oil, which they import from Marseilles and Nice. In his report on the trade of Nantes and St. Nazaire (Annual Series, No. 3972), Mr. Vice-Consul Trillet says there is an opening for firms who could instal tinned sardine factories on the coasts of Morocco and send the sardines direct to the consumers abroad, instead of exporting them to France first. It is probable that fishers and tinners in Brittany would be glad to accept employment, as they have so long been out of work in their own country.

HOME INDUSTRIES.

The Shipbuilding Trouble.—At the time of writing, the likelihood of a settlement in the shipyard strike is not assured. The number of trades that may be involved in the dispute is very large, and the injury done to trade if the dispute is not quickly settled must be very great. The strike of the associated shipwrights, joiners, drillers, cabinet-makers, and wood-cutting machine men has been going on since January. It affects some 5,000 men. Then there are the engineers; 14,000 of these have been on strike since February. And there is the strike at the graving docks of the North-East coast, arising out of the shipyard dispute. All told, some 83,000 members of the various trades involved are affected. The membership of the principal trade societies concerned numbers 201,320, and with funds amounting in the aggregate to £1,318,000. The present deplorable position is at least very largely due to the refusal of the North of England men to accept a reduction that the other workers have accepted, and that the employers insist on as imperative. The North-East coast shipbuilders have been paying higher wages than have been paid on the Clyde, and they fear that their trade will disappear if they continue to do so. In these circumstances they are not likely to concede much for no time could be more opportune to insist upon reduction. Not for many years has the depression in the shipbuilding trade been so great and the prospect of improvement so remote. Moreover, the employers are well organised, whilst the men's trade unions possess little in the way of federated organisation. It is seldom or never that a strike on a falling market succeeds. The demand for industrial products is decreasing, and the men come out on strike when there is not employment, at any price, for all their own members. And the strikes have done something to alienate public sympathy. The engineers rejected the surrender of the federated engineering employers on the subject of arbitration, and repudiated their own executive officials. And so with the wood-workers. In each case the men have refused to follow the central authority of their own trade unions, and have acted in a way so strongly resented by Mr. G. N. Barnes, M.P., that he has felt himself compelled to resign the position of their official representative. The engineers have a large accumulated fund—roughly, £775,000—but it may be doubted whether the large membership, spread all over the country, will long be willing to expend their funds in keeping the North of England marine engineers on a hopeless strike. A good deal is being made of the refusal of the federation of employers to submit the matter in dispute to arbitration. A conference was held in Edinburgh between the executive of the Federation, and representatives of the trade unions concerned, at which the latter were informed that this is a case in which arbitration is impossible, because the issue is simply whether wages shall be, or be not, reduced to the wood-workers and other workers in the industry, and employers have decided that reduction is absolutely imperative. But if the need is imperative and demonstrable, it is not clear why arbitration should be refused. [Since the above was written there have been further negotiations which strengthen the hope of ultimate agreement.]

Trade Marks.—Reference has more than once of late been made in these Notes to the complaints of British traders as to the Japanese practice of imitating trade marks, indeed, adopting them as their own, and the difficulty of meeting the complaint. It would seem, however, from an incident reported by the *Japan Chronicle*, that this dishonest dealing is not only not officially countenanced, but that, at any rate in places, official assistance may be relied upon to stop it. It appears that certain Coventry cycles are very popular in Nagoya and its neighbourhood, which led persons in those districts to imitate the trade mark, attaching it to other cycles. The sole agent in Japan for the Coventry firm discovered this and immediately communicated with the proper authorities, with the result that within two days 26 persons were arrested by the Nagoya police. "The prompt action of the Nagoya police," remarks the *Japan Chronicle*, "certainly deserves commendation, and, in view of the circular issued by the Government recently, foreigners who find their trade marks tampered with should make complaints to the proper authorities, who seem to have instructions to deal with the matter very strictly."

It is not only in Japan that the British manufacturer has had cause to complain in the matter of trade marks. Several cases of infringement have recently come before the Egyptian Courts. In one a Northampton firm of bootmakers prosecuted a number of retailers for selling goods counterfeiting their brand. Another case was brought by a well-known firm of Scotch whisky distillers, by whom it had been discovered that an illicit manufacture of whisky spirit was being carried on in Cairo, the product, an inferior spirit, being sold in the Scotch firm's bottles bearing the original lables. The Egyptian courts have ruled that while in Egypt there is no iegislation on patents of inventions, the law is strict on the protection of lawful foreign trade-marks and inventions, and will be rigorously exercised in defending them from counterfeit.

Textile Machinery.—It is a little surprising, having regard to the slackness of trade not only in the United Kingdom but abroad, that exports of British textile machinery should continue to shew large expansion. If the minor countries of Europe, and China, and Ceylon are excepted, there is continued growth in every direction. Comparing the figures of April, 1907, with those for the same month of 1908, it will be found that the increase in the exports of British textile machinery to Russia has been from £34,447 to £47,961; to Germany, from £74,833 to £89,946; to the Netherlands, from

£16,433 to £18,490; to France, from £67,721 to £74,898; to Japan, from £34,184 to £84,126; to countries in South America from £15,584 to £35,585, to British India, from £146,699 to £162,859.

Iron and Steel.—The outlook for these trades has not improved either in the United Kingdom, or abroad. In April, there was further substantial shrinkage in the number of transactions in crude iron and in finished iron and steel. Many works and blast furnaces are still fairly well off for orders, but with many more there is growing anxiety as to the future. Experts are pretty generally of the opinion that business must remain very dull, and of small proportions, at least until the end of August. The positiou is much the same in Germany as in the United Kingdom. Domestic work has been contracting in volume, and almost all departments show weakness. No serious reduction of the German output of pig iron has yet been attempted. In order to meet the depression, America reduced her pig iron output at the rate of over ten million tons per annum; Germany is reducing hers by 37,000 tons only. It may be taken that when the old shipping contracts are disposed of, Germany will cease to be a large buyer of Cleveland pig iron.

Shipowners and the Workmen's Compensation Act.—At the time of the passing of the Workmen's Compensation Act many representative shipowners expressed the opinion that the additional burden imposed upon them by the Act would be a very heavy one and seriously handicap them, but so far as it is possible to reach a conclusion at present it would seem that their fears had little foundation. The risks covered by the various protecting and indemnity associations work out at an insignificant percentage, and it is quite possible that experience of the working of the Act will lead to a further reduction. Claims have for the most part been settled promptly and generously. Shipmasters receiving more than £250 per annum are excluded from compensation but are being fully covered by the indemnity clubs and by the Shipping Federation. Shortly after the Act was passed a notice was issued by the North of England Association to the effect that captains and officers whose remuneration excluded them from benefit would be protected provided that each was the holder of a Shipping Federation certificate, and that in engaging crews they acted through the registry offices of that organisation. All the protecting and indemnity associations, with the exception of those of Liverpool and London, have since followed suit.

OBITUARY

Charles Edwin Layton.—Mr. C. E. Layton, a member of the Society of Arts since 1866, died on 29th April at his residence, 17, Cornwall-terrace, Regent's-park, at the age of 65. Until 1897, when he retired, he was a member of the firm of Charles and Edwin Layton, printers and publishers, 56, Farringdon-street, which business was founded in 1835 by his father and uncle. He was a director of the old New River Company and of the Company of the same name which was formed to manage the properties not taken over from the old company on the formation of the Water Board. He was also on the Court of both the Habersdashers' and Stationers' Companies, and, since his retirement from active business life, had devoted much of his time and thought to philanthropic work, especially in connection with the various charities connected with the Haberdashers' Company. He was an associate of King's College, a member of the House Committee of St. Bartholomew's Hospital, a member of the Council of King's College Hospital, and associated with many other institutions. He was a generous supporter of the trade charities, and founder of the C. E. Layton Fund in connection with the Printers' Pension Corporation.

Richard Anthony Thompson.—Mr. Richard Anthony Thompson was one of the very oldest members of the Society, as he was elected in 1857, over fifty years ago. He was born on the 30th March, 1819, and at the date of his death, on the 25th March last, was, therefore, only five days short of 89 years of age. He was the third son of John Thompson, the well-known wood engraver, and received his early education at Dr. Birch's Academy in Kensington. For some years he successfully followed the same profession as his father, but in 1850 he was appointed to the staff of the Commissioners for the Exhibition of 1851, where he had charge of a section. In 1852 he accepted the office of Superintendent of the Great Industrial Exhibition about to be held in Dublin. It was there that he had the opportunity of independently demonstrating the gift of organisation that was in after years to stand him in such good stead. On the close of the Dublin Exhibition Mr. Thompson was appointed as an assistant to Mr. Cole (afterwards Sir Henry) in the management of the British section of the Paris Exhibition of 1855, and for the services then rendered received the thanks of the Lords of the Committee of Council on Education who then controlled the Department of Science and Art, in connection with which Mr. Thompson was engaged to arrange the Educational Museum at the South Kensington Museum, the nucleus of which had been derived from the exhibits shown in the Crystal Palace in Hyde-park. Mr. Thompson was appointed on the staff of the Museum at South Kensington on the 1st January, 1857, serving continuously until the date of his retirement in 1891, and discharging during the absence of Sir P. Cunliffe Owen on service in connection with the International Exhibitions in Vienna (1875), Paris (1878), and later, the important duties of Director of the Art Museum. During Mr. Thompson's association with Sir Henry Cole and Sir Philip Cunliffe-Owen, the museum

steadily advanced to its magnificent proportions of the present day, and to Mr. Thompson's capacity for arrangement, as well as to his well-ordered taste for applied arts, may be attributed much of the success attending the display of its many treasures, until want of space led to the congestion that has only now been provided for.

Ever attentive to his duty, invariably of an even temper, with a talent for securing the best services from his junior officers and the friend of all, Mr. Thompson's retirement was a loss keenly felt by his colleagues of all ranks in the Department. In 1862 he assisted in the management of the great International Exhibition, held on the estate of the Royal Commission of the 1851 Exhibition, and received the thanks of the Royal Commissioners and a particularly appreciative acknowledgement from Sir Francis Sandford. He acted as Assistant Executive Commissioner, in company with Mr. Cunliffe Owen, to Mr. Cole at the Paris Universal Exhibition of 1867. On taking his pension Mr. Thompson retired to Sutton where he resided until the day of his death. In 1860, he joined the 1st Middlesex Engineer Volunteer Corps, in which he served for many years, becoming captain of the 3rd, or South Kensington Company in 1863.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

May 20.—"Industrial Entomology: or the Economic Importance of a Study of Insect Life." By F. Martin Duncan.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

May 21.—"The United Provinces of Agra and Oudh." By Sir James Digges La Touche, K.C.S.I., Member of the Council of India and late Lieutenant-Governor of the United Provinces. Sir William Lee-Warner, K.C.S.I., will preside.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 18...British Architects, 9, Conduit-street, W., 8 p.m. Professor Beresford Pite, "London Bridges."

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Victoria Institute, 8, Adelphi-terrace, W.C., 4½ p.m. Mr. F. W. Christian, "The Evidence of Malay, Javanese, Arabian and Persian Admixture in the Inca or Keshna Language of Peru, amongst the Aymara, the Language of the Peasant Class."

Tuesday, May 19...Royal Institution, Albemarle-street, W. 3 p.m. Prof. F. T. Trouton, "What is it which Vibrates"?

Statistical, 9, Adelphi-terrace, W.C., 5 p.m. Mr. Simon Rosenbaum, "Statistics of Food Taxation in the United Kingdom, France, Germany, and the United States."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Wednesday, May 20...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. Martin Duncan, "Industrial Entomology: or the Economic Importance of a Study of Insect Life."

Geological, Burlington-house, W., 8 p.m.

Meteorological, 70, Victoria-street, S.W., 4½ p.m. 1. Mr. B. F. E. Keeling, "Upper Air Observations in Egypt." 2. Professor J. P. d'Albuquerque, "Balloon Experiments in Barbados, November 6th-8th, 1907." 3. Mr. Spencer C. Russell, "Observations on the Colour of Lightning, 1903-1907."

Royal Microscopical 20, Hanover-square, W., 8 p.m. Exhibition of Microscopic Aquatic Life.

British Archæological Association, 32, Sackville-street, W., 8 p.m.

Thursday, May 21...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Sir James Digges La Touche, "The United Provinces of Agra and Oudh."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. A. W. Crossley and C. Gilling, "Hydroaromatic Ketones." (Preliminary Note.) 2. Mr. J. H. Fenton, "Titani-dihydroxymaleic Acid and the Detection of Titaniom." 3. Mr. R. Threlfall, "Some Experiments on Carbon at High Temperatures and Pressures, and Apparatus therefor." 4. Messrs. I. G. Rankin and S. M. Revington, "The Sulphides and Oxy-Sulphides of Silicon."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Alexander Scott, "The Chemistry of Photography." (Lecture I.)

Optical, 20, Hanover-square, W., 8 p.m. 1. Mr. Frederic J. Cheshire, An Experimental Demonstration of "Some New Optical Projection Apparatus." 2. Mr. Val. H. Mackinney, "The Optics of Light Projection."

Electrical Engineers (at the House of the Royal Society of Arts), John-street, Adelphi, W.C., 8 p.m. Mr. H. Hirst, "Recent Progress in Tungsten Metallic Filament Lamps."

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m.

Numismatic, 22, Albemarle-street, W., 6½ p.m.

Friday, May 22...Royal Institution, Albemarle-street, W., 9 p.m. Professor Dr. J. C. Kapteyn, "Recent Researches in the Structure of the Universe."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Physical, Royal College of Science, South Kensington, S.W., 8 p.m. 1. Mr. G. P. Sexton, "The Spectrum Top." 5. Mr. B. W. Clack, "The Coefficient of Diffusion" 3. Mr. B. S. Cohen, "The Production cf Small Alternating Currents of Variable Frequency suitable for Telephonic and other Measurements."

Saturday, May 23...Royal Institution, Albemarle-street, W. 3 p.m. Mr. L. Binyon, "Japanese Prints." (Lecture II.)

Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Journal of the Royal Society of Arts

No. 2,896. VOL. LVI.

FRIDAY, MAY 22, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Conversazione this year will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Thursday evening, the 2nd July, from 9 to 12 p.m.

The programme of arrangements will be announced in future numbers of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

SHAW LECTURES ON INDUSTRIAL HYGIENE—IV.

THE REMOVAL OF DUST AND FUMES IN FACTORIES.

By J. S. Haldane, M.D., F.R.S.

(Fellow of New College and Reader in Physiology, University of Oxford.)

Delivered on February 28, 1908.

Dust, fumes, vapours, and gases are produced in a great variety of manufacturing processes, and as they are nearly all more or less noxious, though in very varying degree, the problem of their prevention or efficient removal is one of much importance to a large part of our working population. My own attention has been specially directed to the subject in connection with the work of the late Home Office Committee on Factory Ventilation, of which I was a member. This Committee has published two Reports (in 1902 and 1907), the first dealing with general ventilation, and the second with the removal of dust and fumes, and with high temperatures. Nearly all the illustrations used in this lecture are from the Appendix to the second Report, prepared by Mr. C. R. Pendock, H.M. Inspector of Factories, Secretary to the Committee.

Whether or not any variety of dust is known to cause dangerous effects when habitually inhaled, I think that every kind of dust produced in manufacturing process ought, as far as practicable, to be prevented, or removed from the atmosphere in which the work-people are present. The reason for this is not only that dusty air is, at the best, unpleasant to breathe, but that when dust is present the clothes, skin, and hair become very dirty, untidy, and uncomfortable. This inevitably tends to lower the social status and self-respect of work-people, if, at any rate, they have to go back to their homes in the same untidy condition. Where dust and dirt cannot be avoided the provision of overalls, or of means of washing and changing clothes on leaving work, is extremely desirable.

In this respect we are, I fear, considerably behind some other nations. To take one instance only, in Germany and Belgium it is now the universal custom for coal miners on leaving work to strip and thoroughly clean themselves in shower-baths provided at the pit-head. They then put on their ordinary clothes, leaving their working clothes behind them, and never bringing dirt and mess into their homes or into public conveyances, &c. Such a thing as a black and dirty collier is not to be seen in Germany outside the collieries, and I think it would be very well for our own colliers and their families if we could have the same arrangement in this country. I recently had occasion to visit a number of colliery

villages in Scotland. A considerable proportion of the men were living with their families in one-roomed houses, to which they returned every day in their working clothes, black, and covered with coal-dust. They doubtless did their best to wash, and their wives did their best to keep the houses clean; but the state of matters under such conditions, and its influences on the miners' families, can easily be imagined. In manufacturing processes where women are employed the desirability of preventing dust, or at least providing overalls, is for obvious reasons greater than where there are only men.

Apart from the reasons which I have just referred to, it is often urgently necessary, on the score of health, to prevent the inhalation of dust. Certain kinds of dust, when constantly inhaled during work, produce in time most disastrous effects, and we may pretty confidently say of every kind of dust—that it is to some extent harmful.

Of dusts which are definitely harmful, one very important class is that from the disintegration of hard stone or other material. As instances of this we may take the dust from siliceous or other hard stone, which has to be disintegrated in the mining of gold, tin, lead, and other metals, and the dressing of hard stone, or the ground flint-dust used in pottery work, or the dust from dry grinding in the metal trades, or the steel dust produced in file-cutting and other work.

To afford some idea of the danger to health resulting from the inhalation of such dust, I may refer to the case of miners in Cornwall, as I was recently engaged in an investigation on their health-conditions for the Home Office.* I ought, however, to mention that a very large proportion of the high death-rate among these miners was clearly traceable to dusty work in mines in the Transvaal and elsewhere. The most dangerous kind of mining work (or indeed of any form of regular work known to me) is working a machine rock-drill in hard and dry stone without a water jet or other means to prevent dust. On investigating the deaths of miners in Cornwall we found that of the men who had died, and been engaged in this work, 94 per cent. had died of lung disease, the average age at death being 37. The accompanying table shows the death-rates of miners living in Cornwall at different ages, compared with the death-rates of coal-miners and other classes :—

Annual Deaths per 1,000 *living at each age.*

	Ages.					
	15–20	20–25	25–35	35–45	45–55	55–65
All miners (Cornwall):						
Lung diseases	0·7	2·7	17·3	33·2	32·2	42·6
All other causes	1·0	3·1	3·6	5·8	12·4	27·9
Coal miners (England):						
Lung diseases	0·9	2·0	2·1	3·5	7·8	18·7
All other causes	2·9	3·6	4·2	6·5	11·6	25·1
Ironstone miners (Engl'd):						
Lung diseases	1·6	1·5	2·1	3·2	6·5	13·0
All other causes	1·8	3·1	3·8	5·0	10·6	20·3
All occupied males (England):						
Lung diseases	0·95	2·7	3·7	5·9	8·6	13·0
All other causes	1·6	2·4	3·6	6·5	12 9	20·7

It will be seen at once that about middle life there is an extraordinary rise in the death-rate from lung disease among the Cornish miners, whereas coal-miners remain healthy. The coal-miners certainly breathe far more coal-dust and shale-dust than the Cornish miners breathe stone-dust; but the coal and shale-dust does little harm to the lungs, while the dust from hard stone is very deleterious. A similar rise in the death-rate from lung disease can be traced to a greater or less extent in many other occupations where dust from hard material is breathed—for instance in pottery work, steel-working, stone-working, ganister mining, &c.

Another dangerous kind of dust is that from poisonous material of any kind. Of more or less poisonous dusts there are many varieties, but the most important kind is lead in any soluble form. If poisonous dust gets about a room it is not only liable to be inhaled, but may easily be absorbed with food. Lead and its compounds are used in many trades; for instance, in house and carriage painting, plumbing work, pottery work, file-cutting. In the manufacture of white lead itself great care is needed.

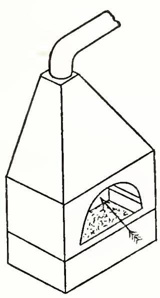
There are many other kinds of dust, which produce less serious, but still sufficiently marked effects; for instance, the dust from flax, or jute, and other textile materials; while in the case of some dusts, such as that from coal or cement making, it is hard to find any definite evidence of serious effects on health.

Fumes and vapours from chemical processes are commonly so unpleasant and irritant in their effects that the necessity of their removal is evident. Fig. 1 shows, in outline, a simple hood and exhaust for removing fumes. The

* Report on the Health of Cornish Miners (Cd. 2091), 1904.

vapour of water, perhaps, needs special mention, as it is so commonly allowed to escape into rooms in the form of steam. A moderate addition of water vapour to the air of a room is often of no importance, provided that no moisture condenses in such a way as to cause damp. If, however, the temperature of a room is high, the addition of water vapour to the air may make it very oppressive. I have recently made many experiments on this point, and find that when the temperature and proportion of moisture are sufficient to raise the wet bulb thermometer above about 70°, considerable oppression begins to be felt in still air with ordinary indoor clothing, which soon becomes more or less wet from perspiration. With the wet bulb above about 80°, a rise of body temperature may very easily occur; and at about 88° or 90° it becomes impossible to prevent rise of body temperature, even when a person is stripped to the waist and doing no work. On account of the discomfort and perspiration produced with ordinary clothing when the wet bulb temperature is above 70°, it is often desirable to limit the escape of steam in hot rooms. Even in the hottest summer weather the wet bulb temperature very seldom reaches 70° in this country in the open air. In a warm atmosphere it is the wet bulb temperature, and not either the actual temperature of the air or the "relative humidity" which is of importance to men. It would much add to the interest of meteorological observations if in warm weather and warm climates more details were given as to the wet bulb temperature and its maximum variations.

Fig. 1.



Hood and Exhaust-Pipe for removing Fumes.

Of poisonous gases the most important is carbonic oxide, which, besides being a constituent of lighting and fuel gas, is present in smoke, the products of imperfect combustion of fuel or fuel-gas, &c. Poisonous gases, if formed in manufacturing processes, ought always to be carried off by proper flues or exhaust ducts, and should never be allowed to escape into the air of a room at all.

I now come to the methods of preventing or removing dust, fumes, or vapours.

Prevention of Dust Formation.

In many cases the best way of dealing with dust is to prevent its formation altogether. This can be effected by substituting wet for dry processes, and fortunately much of the most dangerous dust can be dealt with in this way—in particular the dust from disintegration of hard stone or steel. Thus the use of a jet of water prevents dust formation in rock-drill and other work in tin and granite mining, special rules to this effect being now in force. It is to be hoped that in all cases where dust from disintegration of hard stone, fire-clay bricks, and similar material, is apt to be inhaled, wet methods will also be adopted where possible. The substitution of wet for dry grinding, and for dressing of grindstones* is another important step in the right direction, and I have little doubt that in many other dusty processes it would be practicable to use wet methods, though, unfortunately, wet processes are quite out of the question in very many cases.

Prevention of Escape of Dust.

When dust formation cannot be avoided, its escape can sometimes be prevented by entirely boxing-in the dusty process. Where the dust is itself the product of the process, as in the grinding or breaking up of material, efficient boxing-in is an advantage to the process itself as well as to the persons employed in it. Where the dust is in other ways of some value, the same consideration applies. An interesting example of a somewhat primitive boxing-in arrangement is the box (Fig. 2) used in "flat-knocking," or knocking the loose flint dust off chinaware when it comes from the kiln. The person holding the ware puts it through a small curtain into a box, and then knocks off the dust, which is collected at the bottom for future use. A gentle current of air through the box to an exhaust opening is an improvement. The closed machine recently introduced for carrying out the process of "china scouring"—a dusty process, which in the past has doubtless caused hundreds of

* See the paper by Mr. S. R. Bennet, *Journal of the Society of Arts*, August 30, 1907 (vol. lv., p. 974).

fatal cases of phthisis—is another good example of the application of boxing-in.*

The use of dust-proof arrangements for filling and conveying dusty material, particularly where the dust is poisonous or otherwise dangerous, is a further advance in the same direction. By means of simple mechanisms for this purpose much dust-inhalation and loss of material may be prevented.

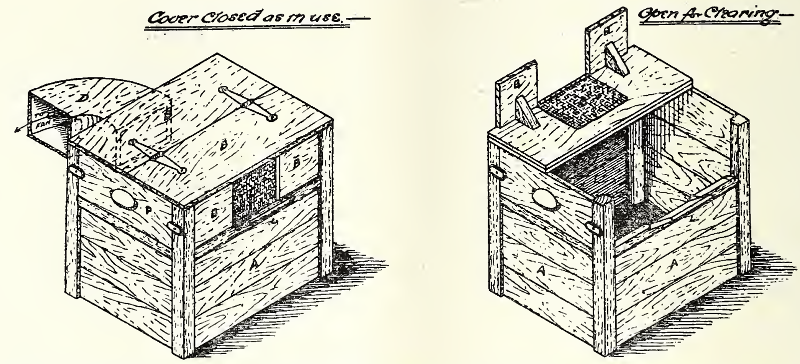
In processes where fumes or noxious vapours are emitted closed vessels ought also to be used wherever possible, and if a closed vessel, or a boxed-in machine, is also connected with an exhaust pipe the fumes or dust are prevented from escaping at times when the vessel or machine has to be opened.

Removal of Dust.

In most cases it is unfortunately not possible to either prevent the formation of dust or to box in the dusty process completely, and the only method available is to draw away the dust by means of an air-current. There are certain general principles applicable to the removal of dust in this way.

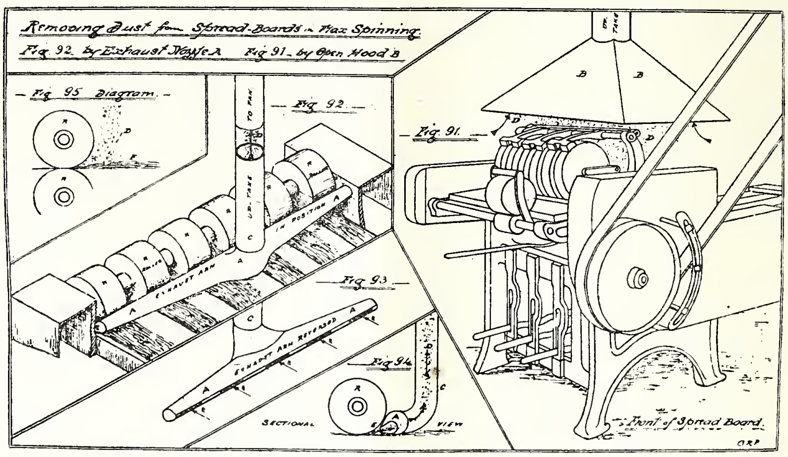
In the first place the dust ought to be removed at, or as near as possible to, the point of origin. The advantages of this are evident; for by this means the dust is prevented from getting into the general atmosphere of the room and being inhaled by those present, as well as settling everywhere. A far smaller volume of air is also sufficient to remove the dust. This is important, not only from the point of view of expense, but because draughts and cold are also prevented. When

Fig. 2.



China Potteries. Prevention of Dust in "Flat-Knocking." A large Box A has a double-hinged cover BB. in which there is an opening covered by a Gauze Cloth C. secured at the top and hanging loosely over the hole. Through this the hands are placed when knocking the Flint Dust from Plates &c. The box A can be Exhausted by propeller Fan by means of a duct at the back

Fig. 3.



* This machine is described and figured in the Shaw Lecture No. III. by Mr. William Burton, who also describes an arrangement by which the dust produced in the grinding of dried clay is effectively boxed-in (see *ante* p. 500).

dust is permitted to get into the general atmosphere of a factory, enormous volumes of air are required to carry it away, which means that equal volumes have to come in from out-

FIG. 4.

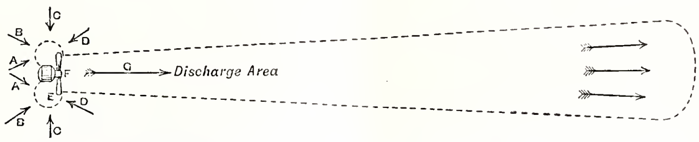
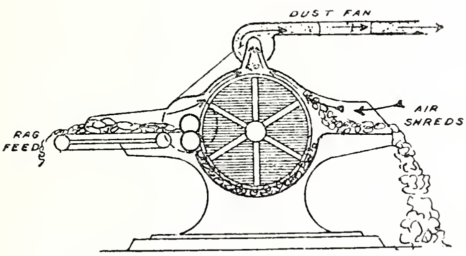


DIAGRAM SHOWING THE AREA WITHIN A CURRENT EXCEEDING TWO FEET PER SECOND WAS PRODUCED BY A PROPELLER FAN.

side, so that warming or prevention of draughts may be quite impracticable. As a good example of the advantage of removing dust locally I may instance a device * for removing

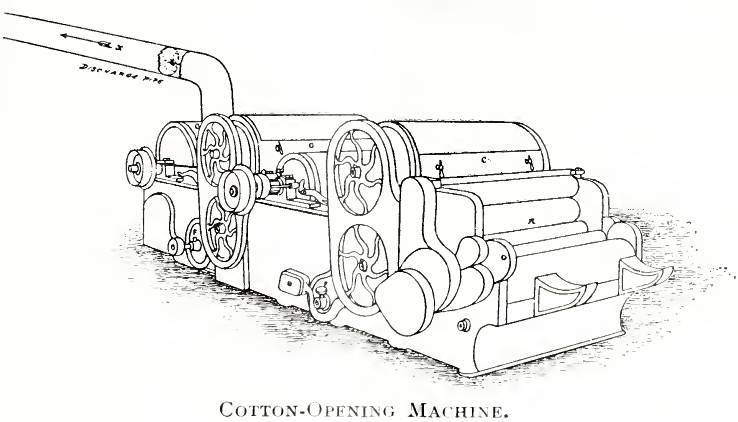
FIG. 5.



RAG-TEARING MACHINE.

the dust produced by rollers in a process preparatory to flax-spinning. The dust produced at the rollers is sucked in by small exhaust openings applied close to the rollers (Fig. 3). A quite small air-current applied in

FIG. 6.



COTTON-OPENING MACHINE.

this way is far more effective than 100 times as great an air-current a few feet off would be. The diagrams from left to right on Figure 3 show (1) where the dust is produced by the rollers, and (2), (3), and (4) the general arrangement of the exhaust openings and exhaust-pipe. On the right hand side of the figure is shown an older and much less efficient arrangement, where the dusty air is exhausted by means of a hood and large exhaust-pipe.

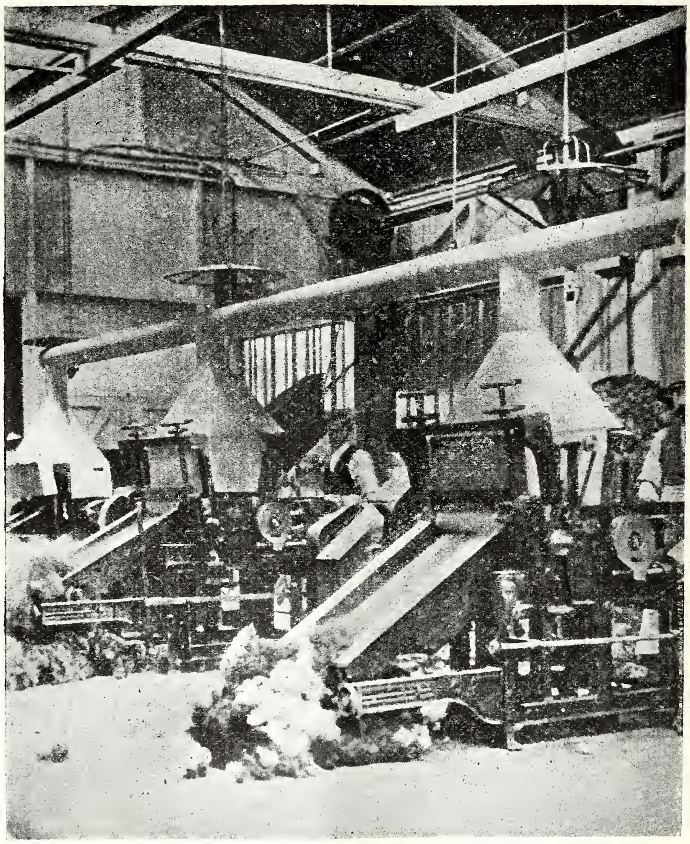
A second general principle is that the air current from the source of dust to the exhaust opening should, as far as possible, envelope the source of dust, and be of sufficient velocity to carry the dust with it in spite of the ordinary slight draughts existing in the room, or produced by the dusty machine. It is unfortunate that in whatever direction an exhaust opening may point, the air entering it is sucked in from all sides. Hence the linear velocity of the draught towards the opening diminishes very rapidly with increasing distance; and at a distance of two or three feet an exhaust opening, unless very large, will fail to carry off dust efficiently, particularly from a machine which itself causes draughts. This is illustrated by Fig. 4, which shows the area within which I found that a fan, running at a constant given velocity, produced a draught of more than two feet per second, as measured by an anemometer. [Illustrated experimentally also.] An air current from an inlet can be directed from it, owing to the momentum of the moving air, but not a current to an

* Designed by Mr. John Gray, of Belfast.

outlet. The source of dust has therefore to be enclosed, as far as possible, by hoods or other coverings, to serve as air-guides. (*See* Fig. 3). When a dusty machine can be enclosed on all sides, except where the material enters or leaves it, a very satisfactory result can be obtained. (*See* Figs. 5, 6, and 7.)

It must not be forgotten, finally, that when exhaust ventilation is used for removing dust, provision must be made for corresponding inlet ventilation to the room, the air being warmed, if necessary. It is not uncommon to see exhaust ventilation rendered partially inoperative by failure to provide proper inlets.

Fig. 7.



Horse-hair Carding Machine.

Where such enclosure is not possible, the best that can be done is so to arrange the inlets and outlets of air to the room that the dust is on the whole carried directly towards the outlets. Fig. 8 shows good and bad arrangements for this purpose. In numbers 3 and 4, the arrangement is such as to carry the dust towards the persons working in the room, while in numbers 1 and 2 better arrangements are shown.

A further important principle is, that as all dust tends to fall, it is often best to remove it in a downwards direction. This applies particularly in cases where the air-current carrying the dust towards the exhaust opening is very slow.

Arrangements of Ducts for Exhausting Air.

The air-currents used for exhausting dust-laden air are nearly always produced by fans; but before referring to the construction and peculiarities of different types of fans it will be convenient to consider the arrangement of the air-ducts leading to the fans, and the causes of resistance to the flow of air.

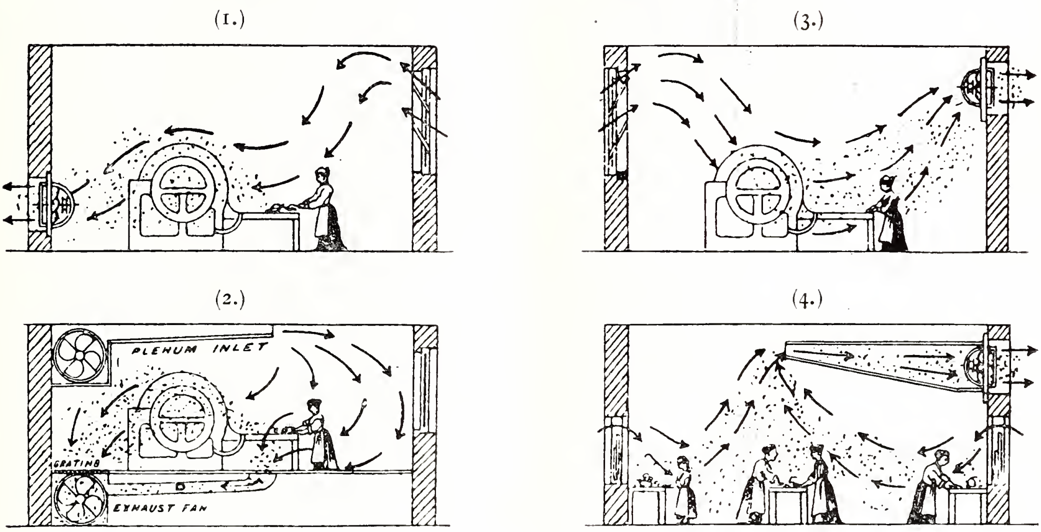
In producing an air-current along a duct we are imparting motion, and therefore energy, to a large quantity of gas. The amount of energy thus imparted—in other words the work done upon the air—varies in proportion to the mass of air moved and the square of its velocity. In the case of an air-current in a

duct, however, the mass moved varies directly as the velocity. Hence the total work done will vary as the cube of the velocity of the air-current, measured at any one point in the duct. The work done on the air is also proportional to the mass of air moved multiplied by the pressure it is moved against, hence this pressure is proportional to the square of the velocity. Bearing these facts in mind we can readily understand the more important considerations relating to the proper arrangement of air-ducts.

It is evident, in the first place, that the greater the sectional area of an air-duct is, the lower the velocity at which a current of a certain number of cubic feet per minute will pass, and consequently the less work (in proportion to the square of the velocity) will be needed to move it. There is, however, little advantage in increasing the cross-section of a duct to much more than the cross-section of the fan opening, as additional velocity would then have to be given to the air as it passed through the fan, with corresponding increase in resistance. Nor would it, as a rule, be an advantage to increase the size of the fan so as to permit of a low velocity through it, as in such a case the current is easily reversed by wind. The space occupied by the ducts and fan is also a material consideration. Any obstruction or narrowing in a duct will correspondingly increase the velocity, and therefore still more the resistance, so that all obstructions should be avoided, including those due to deposits of dust. Any sharp bend converts into heat the energy of motion possessed by the moving air, and an equivalent quantity of energy of motion has again to be communicated to the air beyond the bend. A sharp bend may thus double the resistance, and ought to be avoided if possible. A gradual bend causes much less extra resistance.

A further factor in causing resistance is friction of the air along the sides of the duct. With the comparatively short and smooth ducts commonly used in factory ventilation, this factor is, however, small, and need scarcely be considered.

Fig. 8.



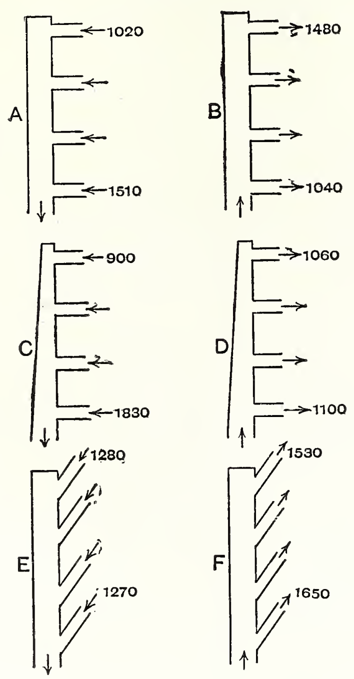
Dust Drawn away from Workers. Dust drawn towards Workers.

Roughly speaking, the cross-section of the duct or its combined branches should be about equal to that of the fan opening; and if a centrifugal fan, capable of overcoming considerable resistance, is used, the duct may be much smaller, and the air-velocity in it much higher, than if a propeller fan is used. As will be explained later, a propeller fan can only work against small resistance, while a centrifugal fan is adapted for much greater resistances. On the other hand, the horse-power required for the centrifugal fan is greater, in correspondence with the greater velocity of the air-current and consequent greater resistance.

An important matter is the arrangement of branch ducts leading into the main duct connected with a fan. In exhausting dust-laden air from several dusty machines or dusty work-places, a corresponding number of branch

ducts are required. If they are not properly arranged the amounts of air passing along the different branch ducts will differ considerably, so that at one place the exhaust current is too strong, and at another too weak. Unnecessary resistance may also be caused. So unsatisfactory was the existing information as to proper arrangement of branch ducts that the Home Office Committee determined to make experiments on the subject, and they were carried out by our Secretary, Mr. Pendock, and myself. A fan was made to draw

FIG. 9.



RESULTS OF EXPERIMENTS ON DISTRIBUTION OF AIR BY BRANCH DUCTS.

or blow air through an experimental main duct with a series of branches, of which the arrangement could be varied at will, the air-currents through each duct being measured with an anemometer. Our object was to test the conditions which lead to equality or inequality of air-flow through branch ducts of equal size.

The first and simplest arrangement tested was a series of branches joining the main duct at right angles, the joint cross-sections of the branch ducts being equal to the cross-section of the main duct, thus carrying out the general principle of avoiding any undue narrowing of the air-way. Fig. 9 (A) shows the results with this arrangement. It will be seen that the rate of air-flow through the branch ducts, as indicated by the figures, was unequal, about 50 per cent. more air entering the nearest than the furthest of the four branches. If the branch ducts were made larger this inequality was increased, while it was diminished if they were made smaller. It might be supposed that the inequality was due to friction along the walls of the main duct, and that owing to increased resistance from this cause in the longer path from the furthest branch less air came this way. That this is not the explanation is clearly seen from the results when the air-current was reversed (B), so that the fan was blowing in, for the flow through the furthest duct was now nearly 50 per cent. greater than through the nearest one. The real explanation depends on the fact that, as already explained, there is resistance wherever motion in a new direction has to be communicated to air. As the branches are at right angles to the main duct each branch air-current, as it enters the main duct, requires to have motion in a new direction communicated to it, consequently the negative pressure in the main duct increases at each junction from the furthest to the nearest branch, and more air therefore flows in at the nearest branch. On the other hand, when the fan blows in air its velocity in the direction of the duct is checked at each junction, and consequently the pressure in the main duct rises from the near to the far end, and most air issues from the furthest branch.

We can equalise the currents through the branches by blocking the ducts to varying amounts. This is, however, a complicated operation, and unduly increases the resistance, since the air has to pass the constrictions at an increased velocity.

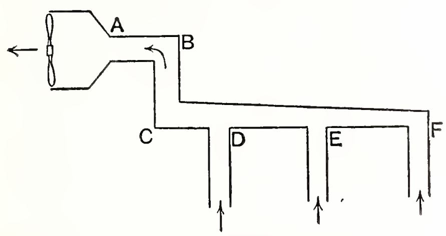
A plan often adopted is to taper the main duct, with the object of keeping the linear velocity of flow about the same all along it. With the fan exhausting, this merely makes the inequality of flow much greater, as seen in C, Fig. 9, since the velocity which has to be communicated to the air from each successive branch duct, is greater than with a duct of uniform cross-section. If, however, the fan is blowing in air (D), a tapering duct equalises the flow from branches at right angles, since the tapering duct prevents the checking of velocity in the main duct at each junction.

Junctions at right angles are a disadvantage for another reason besides the fact that they make the flow through the branch ducts unequal, for a rectangular change of direction in an air current seriously increases the resistance, and thus increases the work thrown

on the fan. With a propeller fan particularly, the result may be very serious, as the fan is only capable of overcoming a limited resistance, and the total flow of air may consequently be greatly diminished. Our experiments were not designed to show this, as we were using a centrifugal fan adapted for high resistances.

The loss of power at the junctions, and at the same time the tendency to inequality in flow through the branch ducts, may be avoided by the simple expedient of arranging the branch ducts so that they join at a slant, as shown in Fig. 9 E, from which it will be seen that when the branch duct joined the main duct at an angle of about 30°, the flow was practically equal through the branch ducts. Whether a uniform or tapering main exhaust duct is employed, this arrangement is the best one. With a tapering inlet main duct, however, the flow through the branch ducts becomes unequal.

FIG. 10.



BAD ARRANGEMENT OF DUCTS.

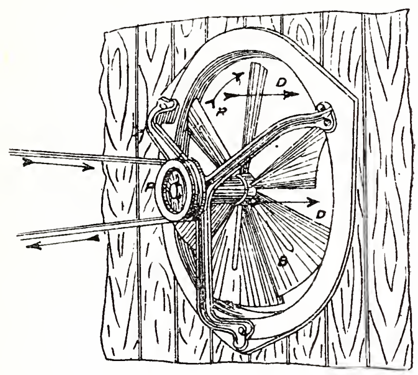
To sum up, a main point to be attended to in the arrangement of ducts for exhausting dusty air, or for blowing air in, is the avoidance of resistance due to sharp bends or constrictions, and the accompanying inequalities of flow in branch ducts. Fig. 10 shows a combination of perhaps the worst possible mistakes in the design of a system of ducts connected with a propeller fan. The constriction of the main duct at A reduces the flow of air to about a tenth; the two sharp bends at B and C, further reduce it to about a twentieth. A still further reduction is caused by the rectangular bends at D, E, and F, while, owing to the latter bends to the branch ducts being too wide in proportion, and to the tapered main duct, nearly all the little air that comes through is exhausted by the nearest duct and hardly any by the further one.

FANS EMPLOYED IN REMOVAL OF DUST.

The air-currents used for the removal of dust are nearly always produced by fans. Two types of fan are employed—the "propeller" and "centrifugal" fan—and the one or the other is most advantageous according to circumstances. Roughly speaking, the propeller fan is best adapted for moving large volumes of air against very small resistance, while the centrifugal fan is necessary when the resistance is at all considerable.

In the propeller fan the blades are arranged similarly to those of the screw propeller of a steamship, the air being moved forward and at the same time given a rotatory motion by their revolutions (Fig. 11). The pressure against which the fan will propel air depends upon the linear velocity with which the blades are moving, and it is evident that this velocity is far greater at the tip of each blade than

FIG. 11.

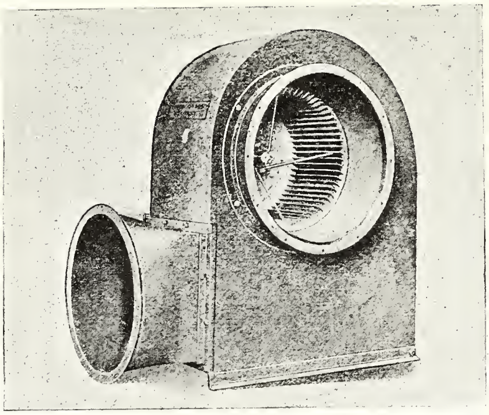


PROPELLER FAN.

near the axis of the fan. Hence it follows that as resistance increases the central part of the fan ceases to deliver air and with further resistance allows air to pass backwards, so that the fan is simply delivering at the periphery of the blades the air which leaks back through it at the centre. For this reason a propeller fan can only overcome very small resistances, unless the central portion is blocked, or the fan is run at a dangerously fast rate. Pressures beyond one or two tenths of an inch of water are usually too much for an ordinary propeller fan to work against. On the other hand, propeller fans have great advantages in the very numerous cases where only very small resistances have to be overcome; and under these conditions they move much greater volumes of air with a given expenditure of horse-power, than a centrifugal fan of any ordinary type. The reason for this is, that a propeller fan itself offers practically no resistance to the flow of air. The air passes straight through it, without there being any change of

direction, and without its velocity being increased by any constriction inside the fan. This is an enormous advantage where the resistance outside the fan is small; and consequently a propeller fan delivers far more air than a centrifugal fan with the same expenditure of energy, if the resistance is very small, although a large part of the energy imparted by a propeller fan to the air is expended in producing a useless rotatory motion. To give an instance showing the large quantity of air moved, and the small expenditure of power when the air supply is unimpeded, a propeller fan two feet in diameter will deliver air at the rate of 170,000 cubic feet of air per hour with a linear velocity of 900 feet

Fig. 12.



Sirocco Centrifugal Fan.

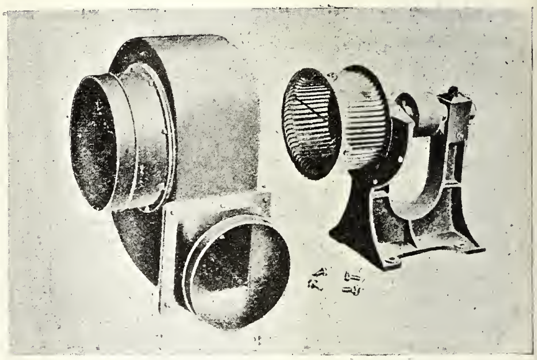
per minute, and an expenditure in power at the rate of only about a tenth of a horse-power. For any given expenditure of power much more air is of course delivered with a low than a high rate of speed, but in practice it is usually necessary to run a propeller fan at a pretty high speed, otherwise the air-current may be very easily diminished, or even reversed, by wind. The retarding influence of wind may of course be prevented by carrying the outlet up to the roof of the building, but this is often inconvenient or impossible.

On account of the serious influence of wind, resistances in ducts, &c., on propeller fans, centrifugal fans are often preferable to propeller fans, particularly for the removal of dust. They also permit of much narrower and less bulky ducts, and air-velocities which prevent choking of the ducts with dust.

In the centrifugal fan (Figs. 12, 13) the air inlet is on one or both sides of the centre of the fan, which is enclosed in a metal case, and the air is by the revolution of the blades driven outwards in a tangential direction into a space between their periphery and the case. As the outline of the case is somewhat like that of a snail's shell, this space gradually increases in cross-section towards the air outlet, so that the air passing outwards between the blades can escape freely at all parts of their revolution, and travel round the case to the outlet.

It is clear that the openings of the centrifugal fan are at the best considerably smaller than that of a propeller fan. The air has also to change its direction abruptly in passing through the centrifugal fan. Hence the internal resistance of a centrifugal fan is much greater than that of a propeller fan of equal

Fig. 13.



Sirocco Fan, showing Fan-blades and Case.

diameter; and if the external resistance to the flow of air is very small, this internal resistance greatly diminishes the volume of air moved by the fan. If, on the other hand, the external resistance due to ducts, &c., is high, the internal resistance is of very little importance. In the centrifugal fan there is no tendency to leakage backwards at one part of the blades, as in the propeller fan. Hence the centrifugal fan will overcome resistances against which a propeller fan revolving at the same rate would be powerless. In short, the centrifugal fan works advantageously against moderate or high resistances, while the propeller fan is only suited for very slight resistances, against which it works more advantageously than a centrifugal fan.

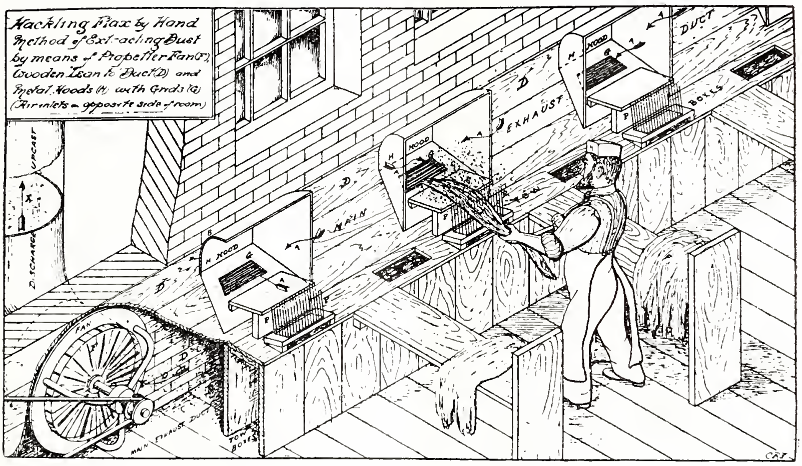
The internal resistance of a centrifugal fan varies considerably with its design. If the inlet or outlet openings are small the internal resistance will be high; and such a fan cannot be advantageously used with the moderate

resistances commonly met with in exhausting dust-laden air. In the "Sirocco" fan, shown in Fig. 12, the openings are very large, so that the internal resistance is reduced to a minimum, and the fan can work advantageously against comparatively small pressures, though also capable of overcoming high pressures.

flax over the hackling pins, so as to comb it out. The dust is drawn away through the hood and exhaust opening.

For such work as wool or rag sorting the material is placed on a grid, with an exhaust opening below, as shown in Fig. 15; the dust formed in the process is then drawn away in a downwards direction.

Fig. 14.



Exhaust Arrangements at Working Places or Dusty Machines.

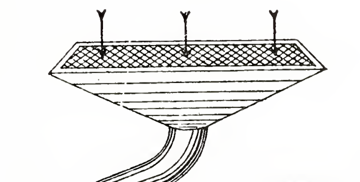
The general principles relating to arrangements for removing dust by exhaust ventilation have already been considered, and it only remains to point out how these principles are applied in special cases.

I may first refer to the case of dusty work performed by hand at a table. A good instance of such work is the process of "towing" or taking the rough off pottery ware. This process and successive steps in the development of an arrangement for safely removing the dust are illustrated in Figs. 1, 2, and 3 of Mr. Burton's lecture. It will be seen that the revolving disc on which the ware is placed during the process is covered in by a hood, open in front, and with a glass top. An exhaust opening at the back communicates with a main exhaust duct, and through this opening the dust-laden air is drawn away. The hood serves to guide the air-flow and also to prevent draughts from carrying the dust about.

Fig. 14 shows a somewhat similar arrangement for drawing off the dust caused in the process of "hackling" flax by hand. In this process the short fibres and other more or less useless materials are got rid of by drawing the

Fig. 16 is from a photograph of a successful arrangement for removing in an upwards direction the dust produced in a rag-cutting and sorting-room of a paper mill. The exhaust openings are placed just over the knives at which the dust is chiefly produced, a very large air-current being employed. The air entering the room is warmed by steam coils.

Fig. 15.



Arrangement of Wool-sorting Table.

Another class of dusty work requiring special arrangement is grinding or polishing on a wheel. As far as possible the wheel should be closely cased in with an adjustable hood, as shown in Fig. 17, the casing being connected with an exhaust pipe, causing a rapid current of air inwards past the exposed part of the wheel. The work should also be done at a

part of the wheel from which the dust is naturally carried into the case. By means of flaps or adjustable slides the arrangement can be improved in various ways.

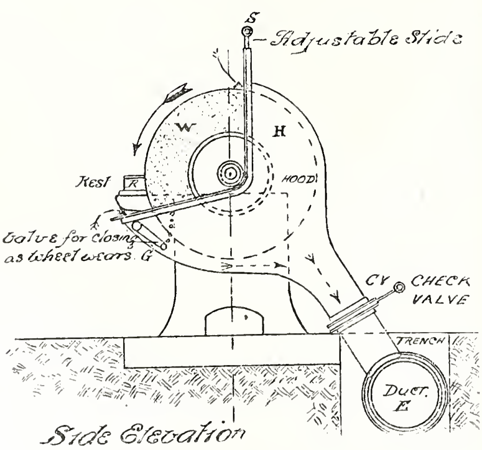
The most difficult cases of all are those of large dusty machines, incapable of being boxed in, and other dusty processes where the source of dust cannot be boxed in, enclosed by a hood, or satisfactorily reached by the openings of exhaust ducts. In such cases a great deal can usually be done by so arranging the exhaust-openings, air-inlets, and positions of

FIG. 16.

REMOVING DUST FROM RAG-SORTING ROOM. METAL EXHAUST DUCTS CONNECTED WITH CENTRIFUGAL FAN.

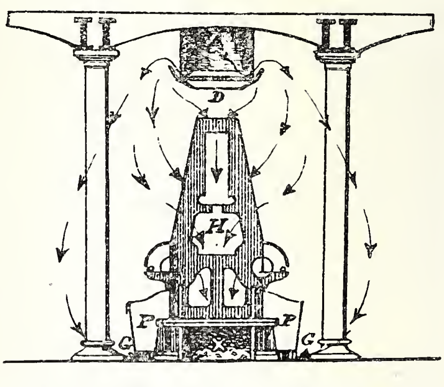
The cases of dust from rollers, and from machines capable of being more or less completely boxed in, have already been referred to in connection with Figures 3, 5, 6, and 7.

FIG. 17.



ARRANGEMENT OF HOOD AND EXHAUST ON GRINDING WHEEL.

FIG. 18.

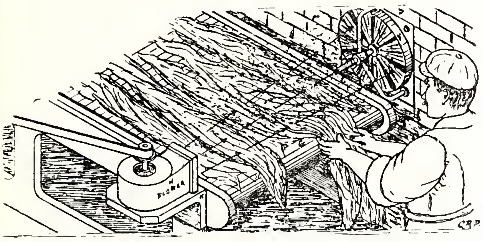


SECTION OF HACKLING MACHINE, SHOWING DOWNWARD REMOVAL OF DUST.

Inlet Duct, A; Deflector, D; Pedestal, P; Exhaust-Duct, X Grid, G.

the dusty machines that the dust is carried downwards and away from the persons who are working. This has already been illustrated

FIG. 19.

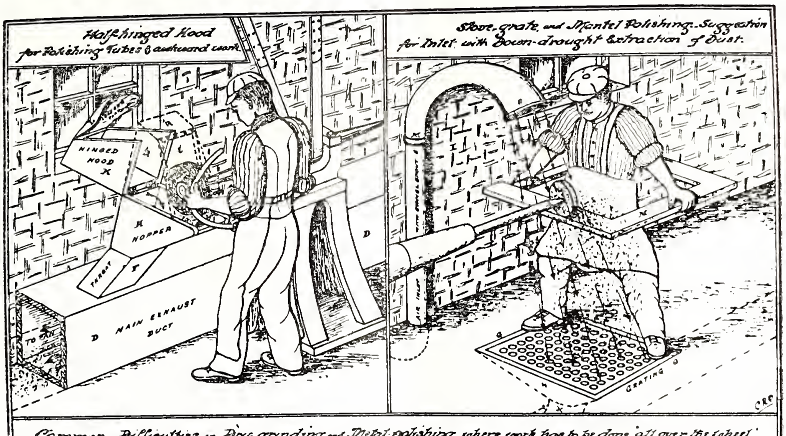


REMOVING DUST FROM FEED OF CARDING MACHINE. COMBINATION OF BLOWING AND EXHAUST FANS.

in Fig. 8. Fig. 18 is a good example of the successful application of this principle to a large hackling machine. When a room is ventilated by extracting air from it anyhow, and without reference to where the dusty machines are situated, the result is apt to be very unsatisfactory, although the ventilation current may be enormous.

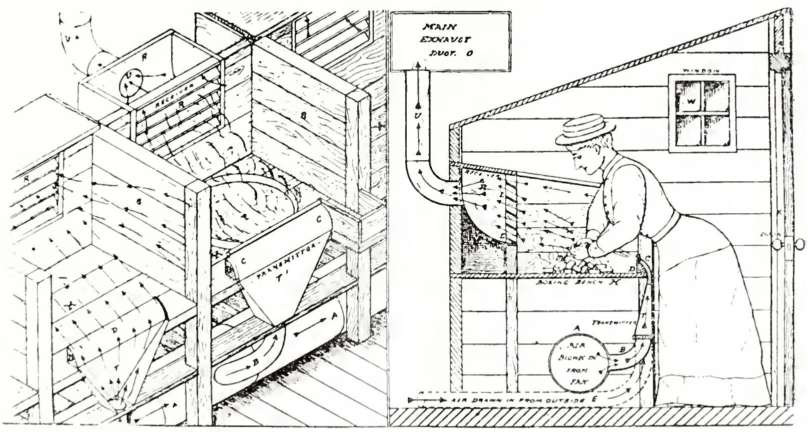
I have already referred to the very limited area over which an exhaust opening acts satisfactorily, and to the reasons for this fact. There is, however, a means of making exhaust-openings effective at considerable distances, namely, by blowing air towards them. [Illustrated experimentally.] If matters can be so arranged that the dust is given off into the path of the air blown towards the exhaust-opening, it is evident that this dust can be carried directly into the exhaust-opening, even though the latter may be at some distance away. We have found this principle actually applied in more than one case. Fig. 19 gives an example where a very small centrifugal fan is used to

FIG. 20.



—Common Difficulties in Dry-grinding and Metal-polishing, where work has to be done 'all over the wheel.'

FIG. 21.



REMOVAL OF PHOSPHORUS FUMES IN MAKING MATCHES.

blow the dusty air towards an exhaust propeller fan from the feeding tray of a carding machine. Arrangements of this kind would seem to be applicable to very many cases. Fig. 20 shows its suggested application to the difficult case of work on an open wheel, which needs to be used in polishing bulky objects, such as steel grates or bicycle frames. Fig. 21 shows a very successful arrangement, designed by Mr. Pendock, for the removal of phosphorus fumes in match-making. A sheet of air is gently blown in at the front of the working bench, and so directed as to carry all the fumes to the lowered exhaust-opening at the back. The worker is thus completely protected from them.

I think there are very many cases which could be dealt with by applying the same principle. Side draughts must, however, be prevented if they disturb the air-flow to the exhaust-opening. This system implies the provision of at least two fans. On the other hand the air-current blown towards the exhaust opening need only be a small one, and may be derived from the general atmosphere of the room. A small blast of air carries with it towards the exhaust-opening a large additional quantity of air.

Time prevents me from going further into detail with regard to plans and apparatus for dust removal, but I hope that I have at least been able to say sufficient to make clear the general principles applicable in the solution of this important but often difficult problem of industrial hygiene.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 20, 1908; P. Chalmers Mitchell, M.A., D.Sc., LL.D., F.R.S., Secretary of the Zoological Society, in the chair.

The following candidate was proposed for election as a member of the Society:—

Dixshit, Hon. Hari Sitaram, 1, Hummum-street, Bombay, India.

The following candidates were balloted for and duly elected members of the Society:—

Li Chun, His Excellency Admiral, The Admiralty, Tien Ping Kai-street, Canton, China.

Low, Charles Ernest, I.C.S., Central Provinces and Berar Exhibition, Nagpur, C.P., India.

Scott-Atkinson, Richard, M.I.E.E., Jesselton, British North Borneo.

Simmons, Rev. Hugh, Mascotte, George-street, Brisbane, Queensland, Australia.

The paper read was—

INDUSTRIAL ENTOMOLOGY: THE ECONOMIC IMPORTANCE OF A STUDY OF INSECT LIFE.

By F. Martin Duncan, F.R.P.S.

At present the public appears to have little or no idea of the very grave importance which the study of insect life has assumed as a factor in the health and prosperity of the nation. Few people, save the little band of scientific men employed in biological investigation, realise, or are aware, that thousands of human beings, horses, cattle, and sheep perish annually from diseases transmitted by insects, yet such is the case; nor is this appalling mortality confined to our possessions beyond the seas, for the high rate of infant mortality from zymotic diseases amongst the working classes of our cities during the summer months of each year, is due very largely to the agency of certain insects.

Formerly the economic study of insect life was confined to the investigation of those insects which were injurious to agriculture and horticulture, good and important work, inasmuch that unless held in check these agricultural insect pests would so quickly multiply that our food crops would be endangered. Recently, however, the study of insect life had become of greater and more far-reaching importance, intimately concerned with the health and prosperity of the Empire.

Only during the last five or six years has the biological significance of the relationship of insects as transmitting agents of disease to man and domestic animals, been realised and fully established. Foremost in this most important discovery, stands the name of Major Ronald Ross, who discovered that the parasite of malaria passes part of its life in the mosquito.

Some twenty years have passed since the discovery by Laveran, a French medical man, of the minute animal parasite in the red blood corpuscles of man which causes malaria. The sexual cycle of the malarial parasite in the blood was successfully demonstrated by Golgi, and is the febrile cycle producing auto-infection of the patient. Major Ronald Ross discovered the further sexual cycle of the parasite in the mosquito, from which new infection in a healthy subject is produced. Let us clearly understand the character of this terrible disease. It is due to the presence in the blood of innumerable minute animal para-

sites, which produce fever recurring every one, two, or three days, and termed, according to their periods, quotidian, tertian, or quartan fever. Now, unless treated by cinchona—quinine—the parasites remain in the body for many years, and cause constant relapses of fever, anæmia, and enlargement of the spleen. In highly malarious districts, the children frequently become infected shortly after birth, and remain infected until the age of puberty, by which time the survivors acquire a partial immunity, therefore the prevalence of malaria in the young children, and immunity, or partial immunity of the adult, points to the disease being long established. In less highly malarious districts the adults are not always immune.

Exactly how infection was produced remained unknown until Major Ross's great discovery of the sexual cycle of the parasite in the mosquito. These insects which transmit the parasite to man are a class of gnats, called anophelines, abounding in marshy localities and the neighbourhood of stagnant pools. The anophelines themselves become infected by biting a person who has the malaria parasite in his blood, and then pass the parasites on to any healthy person they may subsequently feed upon. Notice, therefore, that a district in which anophelines are present only becomes malarious when a person enters it who has the parasite in his blood; that a country cannot become malarious unless both factors be present.

We have a most striking demonstration of these facts in the history of the Island of Mauritius, which prior to 1866 might well have been called an earthly paradise. Prior to that date it was a popular health resort for Anglo-Indians, many of whom were malaria patients. Then, in an unlucky hour, the anopheline mosquito was introduced, and now malaria is endemic in the island.

Sir Patrick Manson, in his "Lectures on Tropical Diseases," gives the following vivid account of the way in which malaria may attack a village community:—"Imagine some district in which anopheline mosquitos abound, but which is luckily free from malaria. A stranger with parasites in his blood comes to the village and is bitten by the local mosquitos, which thus become infected and infective. The disease spreads rapidly and is at first severe. After some years the survivors become immune, or partially so. But the children become infected soon after birth, and continue to be diseased for some years, gradually becoming immune. This is the condition of every village in every highly malarious district; the adults are immune, the children are nearly all of them full of malaria parasites."

There is a singular similarity of effect between malaria and influenza, an effect in which they differ from the majority of diseases, inasmuch as neither strengthen a nation by weeding out the unfit, but produce a general lowering of vitality without a very heavy death-rate. The effect of malaria on its victims is to unfit them for labour, and to diminish generally their producing powers, whilst if left to itself an area so attacked tends towards moral and physical degradation.

The effect of endemic malaria upon the character of a race is demonstrated most forcibly in the Far East, when one comes to compare the extraordinary advance of Japan, which is almost absolutely immune from malaria, with her gigantic but unprogressive neighbour, China, where malaria of a most acute type is always present.

When I was in South America, four years ago, I was much impressed with the extraordinary difference as regards social and commercial life, existing in those malarious and non-malarious districts, which I was able to visit. Perhaps one of the most impressive sights, is that of the burnt-out hulks that one sees on approaching the port of Santos. They are all that remain of vessels whose entire crews perished of malaria and yellow fever. The Santos of to-day, however, is a much healthier place. Unfortunately, very shortly after my arrival in South America, I contracted a severe attack of fever, and was compelled to return home.

Looking at the effects of malaria nearer home, one becomes impressed with what an important part this insidious disease has played in the downfall of the ancient people of Rome and Greece. It is impossible here to do more than briefly touch upon the historical aspect of the disease. It has, however, recently been most admirably and thoroughly expounded in an intensely interesting little book, entitled "Malaria: A Neglected Factor in the History of Greece and Rome," by W. H. S. Jones, M.A.

Prior to 400 B.C. Greece was at the height of her fame and glory—socially, artistically, and philosophically—and prior to that date we find no very clear statement of the presence of malaria to a serious extent. But from 400 B.C. onwards a change gradually came over the Greek character. Patriotism, pride of citizen-

ship, religion, simple living, gave place to effeminancy, sentimentalism, pessimism, immorality; while the writings clearly show that malaria had become endemic. That the anopheline mosquito existed in Greece in very remote prehistoric times, is highly probable, but it does not follow that malaria existed at the same time, particularly if ancient Greece was peopled by a race coming from northern non-malarious latitudes. There seems much more reason to suppose that the malaria parasite was not introduced until after the Greeks had opened up intercourse with Egypt; for malaria is essentially an African disease. Probably the infection was brought from Egypt by slaves and merchants, while many of those Athenians who took part in the disastrous expedition to Egypt in 456 B.C. must have contracted the disease, and returned with the parasite in their blood. The glory that was Greece has long departed; to-day out of her population of some 2,500,000, close upon 1,000,000 people are infected with malaria.

In the struggle for racial supremacy a nation of whom a considerable proportion have passed through an unhealthy, weakly childhood, must be at a serious disadvantage as compared with a healthy, vigorous nation, and as we have seen, when malaria has become endemic, the children are infected with the parasite.

I have mentioned the singular similarity of effect in lowering the vitality between malaria and influenza. It is a similarity that sets one thinking. Is this insidious disease sapping our energies, as malaria of old sapped the life blood of Greece and Rome? What are the effects of influenza? "An intense feeling of inertia. Every action, physical and mental requires an effort of the will to initiate and maintain it that is almost painful. Immobility of mind and body alone seem possible, and yet even rest has to be endured, for it brings no freedom from the sense of prostration. So strange and unfamiliar is the state that it seems at first that it would only be transient, and must be gone to-morrow: but the mistake is realised when day after day, week after week passes without relief. In perhaps the majority of cases it is only after some months that the natural freedom of untrammelled effort is regained." Thus Sir William Gowers describes the post-influenzal state. Environment plays an important part in the effects of a disease, and our modern life with its excitement, deadly trade competition, and intellectual strain, undoubtedly increases the destructive powers of influenza.

But to return to the question of malaria, we have seen how serious is its effect, and it is our duty to do all in our power to stamp it out. The extermination of malaria is a task that concerns us as a nation very closely, for in many of the British possessions, notably India and certain parts of Africa, malaria is an ever-present enemy.

In fighting this deadly disease, it is all important that we should have a thorough knowledge of the transmitting agent between man and man. Thanks to the splendid work of Major Ronald Ross, our knowledge is very complete. The transmitting agent is the spot-winged mosquito anopheles, belonging to the order of *Diptera*, or true flies. Insects which possess a single pair of membranous wings, a suctorial mouth, and undergo complete metamorphosis—egg, larva, nymph, perfect adult insect.

The female anopheline deposits her eggs, from 50 to 150 in number, upon the surface of standing pools of water. The eggs are laid singly without any cement substance, and therefore do not appear as raft-like masses, as is the case with the eggs of culex, the common gnat, but float singly, or touching one another so as to form parallel groups or star-shaped patterns on the surface of the water. When first deposited the eggs are white, but they rapidly darken and become more or less black in colour. They are small in size, from about 0·7 to 1·0 mm. in length, boat-shaped, and stouter at one end than the other. It is from the stout end, containing the head of the embryo, that the larva escapes. The period between the laying of the egg and the escape of the larva depends greatly on temperature and also on the species, varying from about 30 hours to three or four days.

The anopheline larva in general appearance somewhat resembles the larva of the common gnat, but is very easily distinguished from any other mosquito larva. When undisturbed the anopheline larva lies flat along the top of the water, and the curious palmate hairs on the body segments peculiar to anophelines, may be seen to indent the surface film of the water. Another distinguishing characteristic is that anopheline larvæ have no syphon like the larvæ of culex, the stigmatic opening being in the eighth segment of the body, in the form of a large quadrilateral space, with comb-like chitinous processes on either side. The ninth segment is cylindrical in shape and bears four

large transparent papilla well furnished with air-tubes and long curved hairs. While one series of these hairs projects downwards, so as to resemble a rudder, the other projects posteriorly.

Full-grown Anopheline larvæ possess comparatively small heads in comparison to the length of the body, whilst most Culex larvæ have big heads and very prominent, large antennæ. The antennæ of anopheline larvæ are unjointed and rod-shaped, each terminating in two leaf-shaped bodies. If alarmed, the anopheline larvæ will either dart down into the water, or pass along the surface film by a series of wriggling jerks; this latter movement is very characteristic. The nymph or active pupa is a quaint-looking little creature; the head, thorax, legs and wings of the future perfect insect being enclosed in a curious helmet-shaped case. The nymphs of the different mosquitos are much more alike than the larvæ, the syphon tubes which stick out of the back of the thorax being the most distinguishing feature in the identification of the genera. The anopheline nymphs are more elongated, and lie less vertically in the water, than those of the culex.

From the nymphs, in due course, emerge the perfect winged insects. The sexes are easily distinguished, as the antennæ of the male are handsome plume-like organs, and the palps are long and hairy, giving the whole head a conspicuous appearance. The antennæ of the female have very short hairs, and are inconspicuous. While the male is absolutely a vegetarian, only using its proboscis to suck up vegetable juices, the female is a most bloodthirsty creature, piercing the skin with her stylets, and sucking up the blood until gorged to repletion. It is the female anopheline that is the transmitting agent of malaria from man to man, and the sexual generation of the malarial parasite is passed within her body; the resulting needle-shaped spores accumulating in the salivary glands of the anopheline mosquito, and passing out through the insect's mouth when it stabs a fresh victim.

We have seen that the early stages of the mosquito are passed in pools, cisterns, tanks, disused wells, shallow ponds, and similar collections of more or less stagnant water. It is during these early stages that the insects may most readily be destroyed. Unfortunately so prolific are the mosquitos that their natural foes are only of comparatively small help in checking their increase. Their chief foes are small fish and the larvæ of the Dragon fly, Dytiscus water beetle, Corzseta, Nepa, and other aquatic larvæ. It is curious to note also that pools covered with duckweed (*Lemna*), are frequently if not always free from anopheline larvæ. The exact reason for this does not seem to be quite clearly understood, although it is stated that the action of the duckweed is a mechanical one. The method employed for exterminating, or at any rate for decreasing the number of mosquitos, is to pour a small quantity of oil upon the surface of all pools and collections of standing water, so as to form an even, unbroken film over the whole surface. This has the effect of killing all the mosquito larvæ and nymphs that are in the pool, for when they rise to the surface to take in air the oil enters the air tubes of the insects so that they are unable to breathe.

Although so much has been found out about the habits and life history of the mosquito, there still remains a great deal of very valuable and important work to be done. There is a great need for more extended observation and knowledge as to which are the species of anophelines capable of serving as hosts in the Mosquito-man cycle of the malarial parasite. It is not every anopheline that can carry malaria, and, therefore, it is most important to determine accurately those species, which act as the transmitting agents of malaria; in only a very few cases has it been determined which species actually transmit the disease.

We will now pass to the consideration of another, and, from its fatal character, far more appalling disease than malaria, which is also transmitted to man through the agency of certain insects — the terrible disease called sleeping sickness. The disease has existed amongst the natives of the West African coast from the remote past, and seems to occur, though rarely as a very serious scourge, throughout tropical West Africa. Early nineteenth century writers have described the disease as occurring in the plantations amongst the slaves in Brazil and the West Indies. The first printed record of the disease appears to have been written by Winterbottom in 1803. Writing of Sierra Leone, he states that "the Africans are very subject to a species of lethargy which they are much afraid of, as it proves fatal in every instance." The principal symptoms of this dread disease have given it the common name of "sleeping sickness." The unfortunate victim at first becomes dull and apathetic, with a certain amount of fever. Difficulty in speech and

locomotion, producing unsteady gait, tongue tremors, and tremor of the outstretched hand mark the next stage; the patient is oppressed by constant drowsiness, there is fever of an irregular remittent character, with acceleration of the pulse and rate of breathing, and the sufferer is only roused with the greatest difficulty to take nourishment. Finally complete somnolence sets in and no food is taken, while the body becomes emaciated and disfigured by skin lesions, patches of erythema on the thorax, &c., and the unhappy victim dies in a state of coma.

This terrible disease, originally peculiar to tropical West Africa, has crept up the newly-opened trade routes of the Congo basin and spread through Uganda into British East Africa. In the west of Uganda since the disease was first noticed, in 1901, more than 200,000 people have died of it. Out of 300,000 living on the shores and islands of the great lake Victoria Nyanza less than 100,000 remain, the rest have perished within the last five or six years from sleeping sickness. In every case the disease has been transmitted from one victim to another by certain species of true flies. The cause of the disease is the presence in the blood of certain microscopic, motile, flagellate parasites called trypanosomes. These parasites are not confined to man, but are the cause of disease in horses, donkeys, mules, camels, monkeys, and other animals, and are known to be present in the blood of birds, reptiles, and fishes.

The name of the fly that is the principal transmitting agent of the trypanosomes of sleeping sickness is the *Glossina palpalis*, a tsetse fly, and it is almost certain that other species of biting flies, though these have not yet been accurately determined, are also concerned in the spread of the disease.

The transmission of the disease is direct, the fly passing straight from the sick to the healthy persons. In fact it has been proved by experiments on animals that the fly cannot infect a second animal, as the adherent trypanosomes are cleared off in the skin of the first animal bitten, and a fly that has bitten a diseased animal ceases to be infective on the next day, probably much sooner. In spite of this fact, the trypanosomes are said to undergo certain changes in the mid-gut of the fly, two kinds appearing twenty-four hours after the fly has fed upon an infected subject; one a large form, with a short, free flagellum, a large spherical nucleus, and somewhat slow in motion, considered a female; and another, the male, which is slender, active, with a more or less compressed nucleus, and long free flagellum, a common form in blood films. In forty-eight hours, trypanosomes of a different type, with short, free flagellum, the type that is most prevalent in the blood, appear. In ninety-six hours, all trace of the trypanosomes disappears from the tissues of the fly. Whether development of the parasite continues in the tissue of the fly in some different form, causing the fly again to become infective, is at present unknown. It is a curious fact, however, that a certain percentage of tsetse flies that have never fed on human or other blood at all, contain slender and stout forms of trypanosomes in their gut. From the presence of these curious, motile parasites, in blood of persons suffering from sleeping sickness, the disease is now called human trypanosomiasis. The particular species causing this terrible disease, is *T. gambiensis*.

Trypanosomes are also present in the blood of the lower animals, causing various serious diseases, from which the majority of the creatures attacked die. Thus the fatal disease, Ngana and its varieties, so widely spread throughout Africa, is caused by the *Trypanosoma brucei*. Horses, cattle, and many other animals are attacked by it. This disease is transmitted from an infected animal to a healthy one, by several blood-sucking flies, those already known being *Gl. morsitans*, *Gl. Longipennis*, and probably by *Gl. palpalis*, the transmitting agent of sleeping sickness in man, and by *Gl. pallidipes*. Cattle and horses become infected after passing through a "fly belt," that is a tract of country where these blood-sucking flies breed and abound. The flies transmit the trypanosomes which exist in the wild game to the domestic animals. Trypanosomes have been found in the kudu, bushbuck, &c.; and although infected the wild game are apparently healthy. Cattle suffering from a chronic form of the disease also serve to give a constant supply of the parasite. Cattle trypanosomiasis in the Sudan produces a disease which runs a chronic course and may prove fatal. On the other hand, spontaneous recovery may result, particularly if the affected animal is removed from the infected area and is well fed.

T. evansi is the cause of Surra and its varieties, a very widely distributed disease, attacking horses, mules, camels, and in a slightly less degree cattle, in India, Burma, Indo-China, Java, the Philippines, Mauritius,

and North Africa. It is transmitted by various species of Tabanus flies.

In South Africa a cattle disease called gall-sickness (gal-zickte), caused by *T. Theileri*, is transmitted by one of the curious creeping flies similar to our forest fly, called *Hippobosca rufipes*.

T. lewisi is to be found in the blood of a certain percentage of rats all over the world, and is transmitted by means of a rat flea and possibly by the rat louse.

A curious parasite showing regular snake-like undulations in the same plane, present in the blood and causing relapsing fever, in Europe and various parts of the world, is called a Spirochæta, and is chiefly transmitted by ticks. In the European forms of the fever, bugs or lice are the probable transmitting agents.

Spirochæta duttoni is the cause of African tick fever, and is transmitted by the tick *Ornithodorus moubata*, in the adult and nymphal stage.

Diseases transmitted by ticks amongst the lower animals are, Texas or red water fever, Rhodesian fever, or African Coast sickness, Trans-Caucasian fever in cattle, heart-water in calves, sheep and goats, "yellows" the malignant jaundice in dogs, biliary fever in horses, and the fatal *spirillosus* of fowls in Brazil and the Argentine. Evidence is also accumulating to show that the rat tick and not the rat flea may be the real agent in the spreading of plague.

Yellow fever, that terrible disease of tropical South and Central America, and certain parts of the West Indies, &c., is transmitted by a black and white mosquito called *Stegomyia calopus*. Curiously enough the cause of the disease is unknown. The disease is transmitted by a stegomyia mosquito twelve days after biting a patient during the first three days of the fever. The stegomyia breeds, particularly in "domestic" collections of water in pots, pans, tubs, cisterns, troughs, boats, and the like, but not so freely in natural puddles. The American Government have done magnificent work in stamping out this disease in Cuba, and to a great degree in Panama, rendering it possible for the Canal cutting to be carried out.

And now I come to one of the most familiar of our native insects which undoubtedly is a deadly transmitting agent of disease, the common house fly (*Musca domestica*). The part which this insect plays in the transmission of zymotic diseases is due to the peculiar habit it has of feeding or alighting on human excreta, decomposing matter, &c. In his "Report to the Liverpool Health Committee" on the habits and life cycle of this insect, Professor Robert Newstead states that the chief breeding places of the house-fly are :—

1. Stable middens containing fermenting horse manure or a mixture of this and cow dung.

2. Middens containing fermenting spent hops.

3. Ashpits containing fermenting vegetable matter.

Covered ashpits and middens were as badly infested as those which were open.

Temperature plays an important part in hastening the life cycle of the house fly. Eggs hatch in 8 to 12 hours at a temperature of 75° to 80°, in 12 to 24 hours at 60°. The maggots mature most rapidly in fermenting materials in a temperature between 90° to 98°. Though closely resembling the larvæ or maggots of the "bluebottle" or "blow" fly, the house fly maggots are much smaller, and moreover are essentially vegetable feeders; they thrive and mature most rapidly in fermenting materials, under such conditions completing the larval stage in five to eight days. From the somewhat barrel-shaped pupa or chrysalis, climatic conditions being favourable, the flies emerge in from five to seven days, but the pupal stage may last for 14 to 28 days; indeed it is quite possible that some of the autumn insects remain as dormant pupæ throughout the winter. Under the most favourable conditions, the life cycle from egg to perfect insect is completed in about 10 to 14 days. A single fly deposits about 120 to 140 pure white eggs, and probably more than one batch is laid during the life of the insect. The great damage to public health caused by the presence in large numbers of the house fly is due to that insect's inordinate love of humus and decomposing matter. These insects, to quote Dr. Veeder, may, in a few minutes, "load themselves with dejections from a typhoid or dysenteric patient, not as yet sick enough to be in hospital or under observation, and carry the poison so taken up into the very midst of the food and water ready for use at the next meal." (M. A. Veeder, M.B., in "Medical Record," Vol. L. 1. v. (1898), pp. 429-430.

The common "blow" or "bluebottle" (*Calliphera erythrocephala*) is also probably an important factor in the spread of zymotic diseases, for, if anything, it feeds to a greater

extent upon unclean decomposing material than the house fly, and as it is very fond of ripe fruit displayed outside greengrocers' shops, such as plums, pears, cherries, grapes, dried and green figs, dates, &c., it is obvious that this fly has the power to transmit the germs of disease to the fruit. It is, therefore, most important that fruit purchased from stalls or barrows, where it is exposed to contamination, should be carefully washed and thoroughly cooked before being used for food. The eggs of this fly are deposited upon raw and cooked meats, the dead bodies of animals, birds, fish, &c.

The stable fly (*Stomoxys calcitrans*) is very numerous in some seasons, breeding in fermenting horse manure and vegetable refuse. It is a blood-sucking fly, and in tropical countries is one of the recognised carriers of trypanosomiasis.

Homalomyia canicularis is frequently mistaken for the house fly and frequents and breeds in similar situations. Cases of intestinal myiasis in man have been attributed to the larvæ of homalomyia.

Such is a brief outline of our present knowledge of insects as transmitting agents of disease; but brief as it is I trust that it has sufficed to demonstrate fully what vital importance to mankind the biological study of insect life has become, that the future health and therefore success of our Empire, in a very great measure, is absolutely associated with it.

Finally, I would tender my very sincere thanks to Mr. Henry S. Wellcome, and the Director of the Wellcome Research Laboratories at Khartoum; to Dr. Stephens, of the Liverpool School of Tropical Medicine; Professor Newstead; Mr. W. F. Cooper, of the Cooper Research Laboratory, Watford; and Dr. Duncan Reid, of the Lister Institute, for many specimens from which I have been enabled to make photographs, and for much valuable information most generously and courteously given.

The works that should be in the hands of all who are interested in this important branch of biology, are Sir E. Ray Lankester's "Kingdom of Man," in which a very able and clear account of the sleeping sickness, and the discovery of the parasite producing it, is given. "Malaria: A Neglected Factor in the History of Greece and Rome," by W. H. S. Jones; and "The Practical Study of Malaria and Blood Parasites," by Drs. Stephens and Christophers.

DISCUSSION.

Mrs. SINCLAIR STOBART said she understood the author to say that malaria could only be caused after a gnat or mosquito had bitten its victim, and not even then unless a parasite were present. She would like to ask if the author could inform her where the first parasite came from, and what caused it?

Mr. R. INWARDS said it was within his recollection that at a meeting of the Royal Microscopical Society, something like twenty years ago, a paper was read in which it was stated that the house fly was, no doubt, an agent in the transmission of febrile diseases. That paper, however, had been received with apathy and derision, and he did not think had even found its way into the printed Transactions of that Society. Inasmuch as Mr. Martin Duncan's father was President of the Royal Microscopical Society at the time, perhaps he might remember the name of the author of that paper, for he thought that that gentleman, whoever he was, ought to have some little credit accorded to him for having foreseen then that things were quite possible that were now known to be true. Another point which was interesting from a literary point of view was the reference which was made in Defoe's "History of the Plague of London." In that work Defoe had stated that if a patient having plague breathed upon a glass and the glass were looked at through a microscope—and microscopes at that time were very crude and ineffective instruments — forms of serpents and dragons and other monsters might be detected upon it. That, he thought, was an extraordinary instance of a sort of scientific foresight on the part of Defoe, which, though no doubt it came out of his own head, was very interesting, inasmuch as some of the parasites that had been thrown on the screen by Mr. Martin Duncan were very much of the form of dragons, serpents and other monsters. He was glad to hear that the Government were now going to take up the matter seriously and scientifically, for that good results would accrue were shown by the fact that, in Malta, what was known as Malta fever had been entirely stamped out, principally, he believed, at the expense of the Royal Society—a society that well deserved its name, for it had done great service to humanity without any flourish of trumpets, and without receiving any very large amount of praise.

Dr. DUNCAN REID remarked that the diseases which the author had touched upon, at greatest length, had been malaria and sleeping sickness. He had contrasted the condition of things in Japan, with those in China, and had given the impression that China was in a terrible state so far as malaria was concerned. China, however, was a very large place, and though malignant forms of malarial fever were certainly very prevalent in the south, in the north a much better state of things obtained—at any rate that was the case in Shanghai,

as he well knew, having lived there many years,—in fact he could safely assert that no malignant form of malarial fever was prevalent there. Insurance companies were now getting rather better ideas on the subject, but formerly China was considered as a place where it was necessary considerably to increase the premiums of an assured resident. If the insurance companies had the idea that North China was in such a terrible condition as regards malaria, they would undoubtedly still go on charging extra premiums. With regard to the question of sleeping sickness, the author had referred to the transmission of the disease by the *Glossina palpalis* and other flies. In a lecture recently given by Colonel Bruce, that gentleman had given a very interesting account of how he had discovered that the *Glossina palpalis*, and that alone, was the cause of the transmission of sleeping sickness to men. It was Colonel Bruce's idea that it was conveyed by a form of tsetse fly, for he had already discovered that the *Glossina morsitans* was the cause of tsetse fly disease in cattle and horses in South Africa, and he was also of opinion that it was a form of tsetse fly which was the cause of sleeping sickness, although he was not quite sure of it. Colonel Bruce had had collections of all the biting flies sent from different districts in Uganda, and had lists made of all the places where sleeping sickness was found; he then compared the list with the collections of the biting flies, with the result that he discovered that in every place where sleeping sickness was prevalent there also the *Glossina palpalis* was found. Colonel Bruce had, therefore, come to the conclusion that the *Glossina palpalis* was the cause of the disease.

The CHAIRMAN (Dr. Chalmers Mitchell), in bringing the discussion to a close, observed that the paper was so clear and so full of interest that very little remained to be said on the subject. There was one point, however, which he should like to mention. For a good many years the extremely interesting relation which insects had to flowers had been known, as were also the various processes by which they performed the beneficent task of adding to the beauty of the world by fertilising flowers; but the knowledge that many species of insects in addition to playing that beneficent part in many different ways were active malevolent agents in the spread of disease was much more recent than was generally recognised. The importance of diseases, such as malaria, sleeping sickness, yellow fever, and so forth, had brought home to us, much more clearly than most new scientific facts were originally brought home to us, the part played by flies. When it first began to be suspected that flies played the part of active agents in the transmission of disease, it was found that notwithstanding the vast amount of zoological work which had been done before, and was always going on throughout the world, the gaps in our knowledge of the life history of those flies were still very great; and many observers who tried working at special problems in connection with particular diseases were baffled, and for the time put off, and their energies dissipated, because, instead of being able to confine themselves to the precise problem of the disease, they had to set to work to find out the whole of the life history not only of the one particular fly, but of many different kinds. That led him to the point referred to by the author, viz., the formation of the new Bureau which had just been established by the Government. He did not, however, think that the author had quite done justice to earlier efforts on the part of the Government; for, although the Royal Society had done enormous work in this connection, it had been in active co-operation all through with the Colonial Office, and with other Government Departments. It was important to remember that, although that Bureau might, and no doubt would, be an extremely efficient instrument in investigating this particular disease, it was not merely necessary to have bureaux and agencies to work on special problems of the kind, but it was a vital and necessary thing that there should be continuous study of all kinds of living things in the fullest and most elaborate way possible. Twenty years ago none would have had the faintest idea that the study of the life history of flies, and still less the life history of ticks and fleas and various other unpleasant external parasites, could be any more than a rather distasteful piece of scientific curiosity. But suddenly the need had come upon us and we were not ready for it. He only desired to take the opportunity of expressing his own conviction that it was necessary that every department of zoology should be pushed forward and maintained in every possible way, not merely because of its scientific curiosity, or merely as a part of the great study of life, but because it was never known in what obscure corner of zoology some tremendous problem of great practical importance might suddenly arise. It was only by the widest and most general study of the subject that we could be prepared for future emergiencies. In proposing a vote of thanks to the author of the paper, the Chairman said that Mr. Martin Duncan was the son of a distinguished man of science, that he was devoting himself to the study of living animals and plants, and that the improvements he had made in the application of photography to biology promised to bring it about that photography would become not merely a valuable aid to the exposition of science but a new weapon in the pursuit of biological knowledge.

Mr. MARTIN DUNCAN, in reply, said that Mrs. Sinclair-Stobart's question of the infection of malaria was a most difficult one to answer. As he had pointed out, people suffering from malaria had gone to Mauritius and had lived there comfortably and happy for many years, but the disease had never spread till the introduction of the mosquito to which he had referred in his paper. In malaria in man there was what was called auto-infection, in other words

the cycle continued in his blood, causing him to be unwell for a long period; but to complete the whole life cycle the germ had to pass from the man to the mosquito, and from the mosquito, again, to the man. But how the man first got malaria into his blood he could not say. With regard to the early Note on the fly that Mr. Inwards had referred to, it was certainly of great interest, and he would make a point of looking it up in the proceedings of the Microscopical Society. He certainly ought to have remembered his father speaking of it had it occurred during his period of presidency. With regard to Dr. Reid's remark concerning malaria in China, it was certainly worse in the southern portion of that country; and, perhaps, in drawing comparisons between China and Japan he ought to have referred more particularly to South China. As far as the transmission of sleeping sickness was concerned, he believed he had stated, or at any rate he intended to state, that the disease was transmitted by the *Glossina palpalis*, and possibly by other flies, though at present it was uncertain.

The vote of thanks having been passed unanimously, the meeting terminated.

THE AGRICULTURAL INDUSTRIES OF JAMAICA.

The chief agricultural products of Jamaica are bananas, sugar, tobacco, coffee, pimento, cocoanuts, ginger, cocoa, logwood, cassava, cotton, and citrus fruits. Bananas are extensively cultivated, furnishing at present the chief industry and the leading article of export. For the successful culture of the banana, heat, moisture, and rich soil are necessary, all of which requirements are liberally afforded in Jamaica. The present area under cultivation of this fruit is given as 59,958 acres. The output for the fiscal year ended March 31st, 1906, reached a total of 14,981,145 bunches, valued at £842,689, this being the largest export ever recorded from the island. The United States took 10,703,363 bunches, an increase of 5,518,393 over the previous year. The United Kingdom took 1,217,901 bunches, an increase of 522,949. A still better record is shown in the statistics for the fiscal year ended March 31st, 1907. There were 16,000,000 bunches exported, 14,600,000 of which went to the United States, and were valued at £816,000.

Oranges yield abundantly with little or no cultivation; 609 acres are devoted to their production. Improved methods of sorting and packing are being adopted, and exports are gradually increasing. Of the total output for the fiscal year 1906, 44,80,0000 oranges went to the United States, 21,600,000 to the United Kingdom, and 7,500,000 to Canada. A considerable increase occurred in shipments to the United Kingdom and Canada, while in the shipments to the United States there was a decrease of 2,600,000. Of the output for the fiscal year 1907, 18,000,000 went to the United States, 50,000,000 to England, and 10,000,000 to Canada. The cultivation of grape fruit, previously gathered from only wild trees, received an impetus some years ago owing to the demands of the United States market, although this is now largely supplied by Floridian and Californian groves. The fruit has become popular, and exports for 1906 show a valuation of £9,000. Pineapples are not cultivated to a great extent, past experience in the growing of this fruit in Jamaica not having been so successful from a business point of view as in other West Indian islands. The exports of this fruit are at present small, having constantly decreased during the past five years—from 11,806 dozen in 1902 to 3,457 dozen in 1906. Lime trees grow wild on the pasture lands, and yield fruit of good quality even on poor soil. As in the case of pineapples, the exports, however, show a constant decrease both of fruit and of lime juice; 189,000 gallons of lime juice were exported in 1902, and in 1906 only 80,000 gallons, valued at £3,100. A decrease is also shown in mangoes and ginger. The falling off in the cultivation of ginger is said to be due to the great amount of attention now being paid to banana culture, small settlers in the north-western portion of the island having recently largely adopted banana cultivation. There are 259 acres under ginger cultivation, and the exports in 1906 were valued at £26,000, and in 1907 at £22,000.

Vanilla is grown by a few small farmers, though not to any appreciable extent. It is surprising, says the Consul, that the culture of this valuable article is not more generally adopted in Jamaica, especially since it is said that in certain districts in the western portion of the island, the plant grows naturally, even climbing over rocks and trees in the pastures. It would seem that the curing of the vanilla bean as an article of export might prove a valuable industry if seriously undertaken. Pimento is a fluctuating crop, the value of which naturally varies with the yield. The annual production of pimento is from 50,000 to 60,000 bags of 150 pounds' weight. This product, owing to the comparatively cheap cost of labour for gathering, affords a good profit to the grower. The pimento tree is a species of myrtle, grows to a height of about 30 or 40 feet, and begins to bear fruit when about eight or ten years old. The fruit, commercially known as "allspice," is of a glossy black colour when ripe, and about the size of a currant. The area devoted to pimento growing is not at present officially shown. The total exports of pimento in 1906 were 91,736 cwt., valued at £81,000. The United States took 34,935 cwt., the United Kingdom 7,224, British possessions 1,165, and other countries the remainder. The total exports for 1907 were 85,000 cwt., valued at £79,000, of which the United States took 40 per cent. Jamaican coffee was exported in 1906 to the amount of 80,772 cwt., valued at £130,000. For the Blue Mountain coffee Jamaica holds a reputation of its own, and the claim is made that it is excelled by no other berry. This particular coffee is

grown at an altitude of between 3,000 and 4,000 feet, and for most part on established plantations. The bulk of the island's coffee production, however, is grown by the peasantry. The total area under coffee cultivation is given as 27,765 acres. Cocoanuts are grown in nearly every portion of the island, the yield per tree being estimated at 100 nuts. The hurricane of 1903 devasted the cocoanut plantations greatly, the present yield being somewhat less than one-third that of four years ago. Careful replanting has, however, been done, and earnest efforts are being put forth to restore and extend cocoanut cultivation. About 300,000 more cocoanuts were gathered in 1906 than in the year preceding. The shipments are given as 7,100,000, the value being £28,000. Figures for the year 1907 show the value of total exports as £44,000, divided among the United States, the United Kingdom, and Canada. The production of cocoa is on the increase in Jamaica owing to the establishment of cacao plantations by the banana growers in connection with the banana industry. Still further development in this direction is assured, as such method of cultivation has proved satisfactory. An area of 6,021 acres is now under cacao cultivation, while the exports for 1906 were 31,066 cwt., valued at £53,000. Exports of cocoa to the United States in 1907 were valued at £29,000.

One tea plantation exists on the island, comprising about 80 or 90 acres. Tea growing would, it is said, be much more largely extended were it not for the expense attached to the cultivation of the plant while waiting for maturity, the time required being about five years. The plantation in question is situated in the parish of St. Ann. The factory in which the tea is cured and prepared for market is equipped with improved machinery, and an article of good flavour and quality is turned out. Tobacco in Jamaica is cultivated on about 260 acres. The tobacco districts are situated in the parishes of St. Andrew, St. Catherine, and Clarendon, in the southern part of the island. In 1906 the number of cigar factories in the island was sixteen. The following quantities of tobacco were exported in 1906:—Cigars, 40,325 lbs.; cigarettes, 11,261 lbs.; leaf, 6,554 lbs.; the total value being £2,000. Under sugar-cane cultivation there are at the present time 26,838 acres, Westmoreland, Hanover, St. James, Trelawny, and the southern portion of Clarendon being the principal sugar-growing districts. Cane cultivation is increasing, and the introduction of improved machinery is gradually tending to lessen the cost of production. In 1906, 238,690 cwt. of sugar, valued at £123,000, were exported, the greater part being taken by British Possessions and the United Kingdom. For the fiscal year 1907, exports of sugar amounted to 278,000 cwt. Of rum, 1,130,500 gallons were exported in 1906, the value being about £100,000. The value of rum exported in the year ended 31st March, 1907, was £135,000, most of which went to the United Kingdom. Jamaica affords good opportunities for cotton-growing, although its cultivation was largely abandoned for many years and the attention of growers given to cane. About 500 acres are now under cotton cultivation, and the returns per acre have proved satisfactory. The rearing of cattle, horses, and mules is an important industry in Jamaica. Dairying is not carried on to any great extent, the native cow not being a good milker. Jamaica must, therefore, draw largely upon foreign supplies for butter and cheese. Bee keeping resulted in export returns of honey amounting to £10,000 in 1906.

THE LIQUOR TRAFFIC IN SWITZERLAND.

In Switzerland, the laws governing the sale of intoxicants are cantonal, each canton legislating on the subject in a way that is considered best for the locality. The general plan is to limit the number of drinking places, or bars, in proportion to the population. The average is one for about five hundred inhabitants, although in some towns and cities the proportion is one for each two hundred, while in the rural districts, the basis is not infrequently as high as one per thousand. In the canton of Lucerne, the cost of a license is comparatively high. Drinking-places are classified, the privilege of opening a bar in a first-class hotel costing much more than in the case of a small restaurant or public house. The American Consul at Lucerne says that each municipality or community decides the number of places to be licensed, based upon the number of inhabitants, and when the number prescribed has been reached, no influence, political or financial, can secure an additional privilege. The hour for closing is generally 12 o'clock at night, and as a rule it is strictly observed, any violation of the law resulting in forfeiture of the license. Any special privileges desired by the holder of a liquor license must be applied for to the proper authorities, and, if granted, they must be paid for in addition to the regular annual fee. All license fees in Switzerland must be paid one year in advance, and any neglect on the part of the holder to comply with this requirement results in a forfeiture of the license. There are are no technicalities of the law governing the traffic whereby the holder of a license can avoid a strict compliance with its requirements. The limited number of licenses issued also encourages the strict observance of the law, as the license is considered valuable because of the fact that when the maximum number allotted to a community has been issued, it is impossible to secure an additional privilege, until one is surrendered or forfeited. All the revenues derived from liquor licenses are expended upon public schools, and the improvement of roads in the canton where the privilege is granted. Three-fourths of the money thus collected are apportioned for educational purposes, and the remainder for public highways. The drinking of alcoholic beverages is general, but not excessive, among the male, though not common among the female Swiss

population. There is little drunkenness in the country, especially in German Switzerland, where the beverages most commonly consumed are beer, light wines, and cider. An intoxicated person is rarely seen in the streets of Lucerne, according to the Consul. The net result of the liquor traffic in Switzerland would seem to be that it is regulated so as to secure a large revenue which is applied mainly to a maintenance of public schools, and at the same time so restricted as to prevent any abuse of the privileges granted with a license to engage in the business.

THE RAILWAY TO JERUSALEM, AND ORANGE CULTIVATION.

Reporting on the trade of Palestine for the past year (Annual Series, No. 3974) Mr. Consul Blech refers to the projected railway from Haïffa to Jerusalem. He says this undertaking has been decided upon, and that it is to be completed within two years. A new means of access to Jerusalem will thus be afforded, which should prove a great boon, as the dangerous and frequently impossible landing at Jaffa will be avoided. But it will be necessary to build a port at Haïffa which, though possessing natural advantages, is at present but little better than Jaffa. The construction of the projected railway, which will probably be some 100 to 120 miles in length, will no doubt injure Jaffa by diverting from it a portion of the pilgrim and passenger traffic, and it is feared that the Government will do all in its power to favour Haïffa at the cost of Jaffa, in the interests of the Hejaz State Railway. But it is unlikely that Jaffa will ever lose its position as the port for Jerusalem and the neighbouring region, while the growing export trade in oranges will maintain its importance as long as the fruit finds a ready sale in the United Kingdom. The future prosperity of the plain of Sharon seems in great measure to depend on the orange export. In 1897, only 290,000 cases were exported; the total has now risen to 630,000 cases, and it is confidently expected that within a very few years the output will reach 1,000,000 cases. The case contains from 100 to 150 oranges, according to the size of the fruit; the weight is about 80 lbs., and the freight to Liverpool about 1s. 3d. per case. It is usual for the owners of orange gardens to sell the produce long before it is ripe to speculators who thus take off their hands all further trouble and responsibility. The price so obtained by the grower is about 2s. 4½d. per case; the cost of packing is estimated at 1s. 2d. Anything obtained over 4s. 9½d. per case at Liverpool represents the speculator's profit, on whom, however, falls all loss incurred through hail storms, such as have lately prevailed, as well as all other risks, until the fruit is shipped. It would seem from these figures that the grower gets a little less than a farthing apiece for oranges sold in London shops at twopence.

HOME INDUSTRIES.

The Hop Industry Crisis.—The critical position of the hop industry is exciting unusual attention just now. Last week there was a debate in the House of Lords upon it, the Select Committee appointed by the House of Commons took important evidence, and on Saturday some 50,000 workers met in Trafalgar-square for the purpose of influencing Parliament to do "something" to save the industry. Unfortunately, no one is very clear as to what that something — the something being practicable—is. The hop-growers want a duty on foreign hops; but whatever may be said for or against the suggestion, there is no likelihood of it whilst the present Parliament lasts. There is strange difference of opinion upon salient facts bearing upon the situation. For example, both in the House of Commons and in the House of Lords, leading speakers attributed much of the trouble to increase in the importation of foreign hops, but available statistics show that this import has not been abnormal, and if it has been during the last few weeks that would not explain the present distress and the grubbing of 5,000 acres since October. Then as to the cost of cultivation, the President of the Board of Agriculture, speaking in the House of Lords, put it at "from £50 to £60 per acre," whereas in fact, as other speakers insisted, it is not much more than £40. Expert evidence given before the Royal Commission of some years ago, put it at about that figure, and Mr. Charles Whitbread, in his paper on "Fifty Years of Hop Farming," read before the Royal Agricultural Society, put it considerably less. The average yield, taking the last ten years, has been a fraction over 8 cwts. per acre. For last year Kent reported an average for the year of 6½ per cwt., with variations of from 7½ to 10 cwt.; and Worcester and Herefordshire of 7½ to 8 cwt. per acre. Given an average crop of 8 cwt., and putting the cost of production at £40 per acre, the average price got must not be less than £8 per cwt. before expenses can be covered. The present quotation for hops can leave no profit. The price of hops has varied considerably in the past. It has touched £23 per cwt., and it has been as low as £3 15s. The average price for twenty-eight years after the repeal of the hop duties, ended 1889, was £6 17s. 6d. per cwt., including the high average of £18 10s. made in 1882. In most parts, therefore, taking one year with another, hop cultivation would seem to have returned a handsome profit to the grower. And very large profits have been made; £100 per acre has frequently been realised, and crops of a ton per acre have been known. But it must not be assumed that a big crop necessarily means a big profit. Here, as in other ways, the hop is peculiar. It is in the short cropping years that hitherto the losses of other years have been made up. For instance, take the cost of picking alone. On very small acreage it has sometimes come to as much as £400 on a large crop, whereas upon a smaller crop of from 5 cwt. to 7 cwt.

per acre, instead of 18 cwt., it would be reduced by half. It does not follow that because a crop is a small one, therefore it is an unprofitable one, or because it is a large one, it must necessarily be a very profitable one. Quality, which is dependent upon the atmosphere and price, to some extent affected by imports, are the determining factors, assuming the demand to be unchanged.

What the Loss of the Industry would Mean.—Unfortunately for the hop grower the very high prices of the past are not likely to recur. The brewer uses less hops than he used to do, and he has better means of carrying them from one season to another, which makes it easier for him to keep out of the market when prices are abnormally high. And this is amongst the most important factors in the situation, and makes it more than anything else a seemingly hopeless one for the grower, for he cannot reasonably expect in the future those very high prices in exceptional years, which, in the past, made the price over an average of years sufficiently high to insure a fair, and, in many cases, a handsome return upon capital. It is most earnestly to be hoped that some means may be devised to preserve the hop industry from extinction, and the report of the Committee now sitting is awaited with anxiety in order to see whether it is able to make any practical proposals on behalf of the industry. What its extinction means to a locality may be gathered from a statement recently made by Mr. A. W. Herdman, of Ewhurst-place, Haukhurst, who has decided to relinquish farming on account of recurring losses on his hops. Until this year, Mr. Herdman had 25 acres under hops, and taking the cost of production at £45 per acre; inclusive of picking and drying, his total outlay was £1,125, or deducting manures, £600 in labour, £400 of which was paid to local or permanent labourers. He has let his farm, but the new tenant has stipulated that he shall be allowed to grub all the hops. For the present the tenant is to retain the 25 acres under rotation cropping, and this will mean an expenditure in labour of about £100, instead of £600 on that portion of the farm, and £370 of the £500 will be lost to the village.

Dust in Card-rooms.—As was to be expected, the deputation that recently waited upon the Home Secretary on the subject of dust in card-rooms was received very sympathetically. There seems to be little doubt that conditions might in many cases be improved. One mill differs materially from another in this respect, and allowances must be made for differences in the character of the raw material, but existing conditions might in many cases be considerably improved by the introduction of an adequate system of ventilation. It is generally admitted that the conditions prevailing in some mills are injurious to health, and though it may be difficult to provide a remedy it ought not to be impossible. Indeed, mechanical contrivances already exist which are of proved value in this direction. As the *Manchester Guardian* points out, the improvement effected in respect of the removal of fluff from certain flannelette raising-rooms by an adequate system of exhaust, may well serve as an object-lesson to spinners and others who may require convincing.

Fire Insurance and Earthquake Risks.—The Tariff Fire Offices have decided to insure property in the United Kingdom against loss by fire arising out of earthquakes. It would seem to be a safe development seeing how little the United Kingdom suffers from earthquake upheavals, and probably the minimum rate of 6d. per cent. decided upon will prove to be ample to cover the additional risks. Until recently the Associated offices refused to underwrite this risk on any conditions, but the public misgivings occasioned by the disasters in San Francisco and Jamaica, and the complications arising therefrom, have induced a change of policy. It remains to be seen whether the home public will be willing to pay the additional rate to cover a risk that most of them may think too remote to be seriously reckoned with. If, however, there is general, or considerable response on the part of insurers, it may be taken that it will not be very long before the conditions attached to all policies exempting the offices from liability in the event of fires occasioned by riot, foreign enemy, or military or usurped power will also be taken out of fire policies on payment of a slight additional premium.

The Patent Acts and Appeals.—In commenting upon the working of this Act Mr. E. Lunge points out that although many, and very complicated questions arise on the interpretation of Section 27, the patentee has no right of appeal beyond the one Judge to whom the matters are assigned. A County-court action may be taken to a Divisional Court and the Court of Appeal, but their protection is denied to the whole class of patent cases under notice. In carrying the Consolidation Bill, Mr. Lloyd George inadvertently abolished the right of appeal on all petitions for revocation. Lord Granard's "Interpretation Bill," now before the House of Commons, does indeed attempt to correct the error to some extent, but still leaves the inventor without the protection of the Courts of Appellate Jurisdiction when a patent is revoked, as an alternative to a compulsory license, or on the ground of inadequate working in the United Kingdom.

The Shipbuilding Dispute.—To-morrow, the ballot among the shipyard workers, on the terms submitted for a settlement of the dispute, is to be completed, and the papers are returnable to London on Monday. It is feared that the majority of voters will reject the terms, and that the result will be against a settlement. The men on the north-east coast are said to be determined to accept no reduction, and it is not unlikely that the men on the west coast, resenting the action of the employers in locking them out after they

had accepted the reduction, will show themselves to be of like mind. It is earnestly to be hoped that the men will listen to the counsels of conciliation and prudence, for it is impossible to deny a genuine depression in trade, and it is hard to see how the men can succeed if they push matters to extremity. It is ill striking on a falling market.

CORRESPONDENCE.

MODERN ROUMANIA.

Sir Henry Trotter writes:—As the condensed report of my remarks in the discussion on Roumania, in the Society's *Journal* (May 1st), p. 627, gives a misleading impression of what I said about M. Sturdza, will you allow me to supplement and correct them by the following explanation:—When, as Prince Charles, the present King first came to the country, he was a very young man, and had great difficulties to encounter, which he had overcome by his personal ability. In 1870 there was a conspiracy to remove him, said to have been instigated by M. Bratiano, and led by a hot-headed lawyer, Candiano Popesco. It failed, but it may be noted, as showing the magnanimity of Prince Charles, that Bratiano lived as Prime Minister to render the greatest service to his Prince and country, while Popesco, some years later on, during the Turko-Russian war, led the Roumanian battalion which stormed and captured the famous Grivitza Redoubt at Plevna. As regards M. Sturdza, the present Prime Minister, he was a man of very great capacity, and one of the most energetic and hard-working men he had ever met. In and out of office he was never idle, and although short of stature he was head and shoulders above his contemporaries in administrative ability.

GENERAL NOTES.

River Connection between Rome and the Sea.—A Royal Commission was appointed some time ago to study and report upon the important question of the proposed river communication between Rome and the sea. Up to the present all goods sent by steamers from Rome and its district are either unshipped at Civita Vecchia, a distance of some fifty miles, or at some other more distant port. Two schemes were submitted to the Government for connecting the city with the sea, which is only at a short distance, and the Royal Commission has now adopted the one prepared by the Italian Board of Works, who advocate the dredging of the Tiber to a depth sufficient to allow ordinary steamers to approach Rome. In his report just issued (Annual Series, 3987), Mr. Consul Morgan, referring to the matter, says that important works are to be carried out at the river's mouth (Fiumicino) so as to facilitate the passage of vessels. The idea of excavating a large canal from Rome to the sea without in the least interfering with the river has been abandoned as much too costly, and out of proportion to the commercial requirements of the district.

Tea Consumption.—It is satisfactory to note the increase of seven million lbs., during 1907, in the world's use of British-grown tea, and that consumption showed an excess, over production, of $8\frac{3}{4}$ million lbs. The total exports from the two producing countries were rather heavier, but the increase is moderate when compared with that of 1906 over 1905. Figures compiled by Messrs. Gow, Wilson, and Stanton show that the exports of tea from India and Ceylon, in 1907, amounted to 413,715,009 lbs. as against 403,517,388 lbs. in the preceding year, and 329,112,682 lbs. in 1902. Of last year's exports, 249,568,693 lbs. (not counting ships' stores) were consumed in the United Kingdom. With a steady expansion in the demand for Indian and Ceylon teas in foreign countries, and with no material increase in the planted area, a repetition of the unsatisfactory position which ruled during 1903, 1904, and 1905 appears unlikely. The Ceylon exports for February are wired as 8,000,000 lbs. against 8,850,498 lbs. for the corresponding month of last year, and from Northern India, 43,000 lbs. against 491,000 lbs. This practically closes the Indian crop, the total to the United Kingdom being 160,938,000 lbs. against 169,070,000 lbs. last season.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 25...Geographical, University of London, Burlington-gardens, W., 3 p.m. Anniversary Meeting.

Tuesday, May 26...Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Stirling, "Animal Heat and Allied Phenomena." (Lecture I.)
Zoological, 3, Hanover-square, W., $8\frac{1}{2}$ p.m.
Faraday Society, in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W., 8 p.m. Presidential Address by Sir Oliver Lodge, "Some Aspects of the Work of Lord Kelvin."

Wednesday, May 27...Royal Society of Literature, 20, Hanover-square, W., $8\frac{1}{2}$ p.m.
British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

Thursday, May 28...Electrical Engineers (at the House of the Royal Society of Arts, John-street, Adelphi, W.C.), 8 p.m. Annual Meeting.
Royal, Burlington-house, W., $4\frac{1}{2}$ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. Scott, "The Chemistry of Photography." (Lecture II.)

Friday, May 29...Royal Institution, Albemarle-street, W., 9 p.m. Sir Ralph Payne-Gallwey, "Ancient and Mediæval Projectile Weapons other than Fire-arms."
Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Paper on "The Influences affecting Modern Design."

Saturday, May 30...Royal Institution, Albemarle-street, W. 3 p.m. Dr. H. W. Davies, "The Art of Bach and Future Developments." (Lecture I.)

Journal of the Royal Society of Arts

No. 2,897. VOL. LVI.

FRIDAY, MAY 29, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

INDIAN SECTION.

Thursday afternoon, May 21; SIR WILLIAM LEE-WARNER, K.C.S.I., in the chair.

The paper read was "The United Provinces of Agra and Oudh." By SIR JAMES DIGGES LA TOUCHE, K.C.S.I., Member of the Council of India.

The paper and report of the discussion will be published in a future number of the *Journal*.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Thursday evening, July 2nd, from 9 to 12 p.m.

The following portions of the Museum will be open:—

The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions; protective resemblance, &c. Also models of the Tsetse-Fly, the Malaria Mosquito, and the life history of the Malaria Parasite. A splendid specimen of the Sea Elephant has recently been placed on exhibition here.

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrated Animals of the British Isles.

The Gallery, containing the Reptiles, including the three gigantic fossil forms *Diplodocus* and *Triceratops* from Wyoming, U.S.A., and *Iguanodon* from Bernissart, Belgium.

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

The Reception, by Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert, under the direction of Mr. Harry Tipper, will be given in the Reptilia Gallery from 9.15 till 10.15 p.m., and from 10.30 till 11.30 p.m.

A Gramophone and Auxetophone Concert, under the direction of the Gramophone Company, will be given at the Western End of the Bird Gallery at intervals from 9.15 p.m.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the day of the conversazione. On that date the price will be 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

A programme of the arrangements for the evening will be published in due course.

PROCEEDINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evening, April 28; ALAN S. COLE, C.B., in the chair.

The paper read was—

LACE AS A MODERN INDUSTRY.

By MISS ISEMONGER.

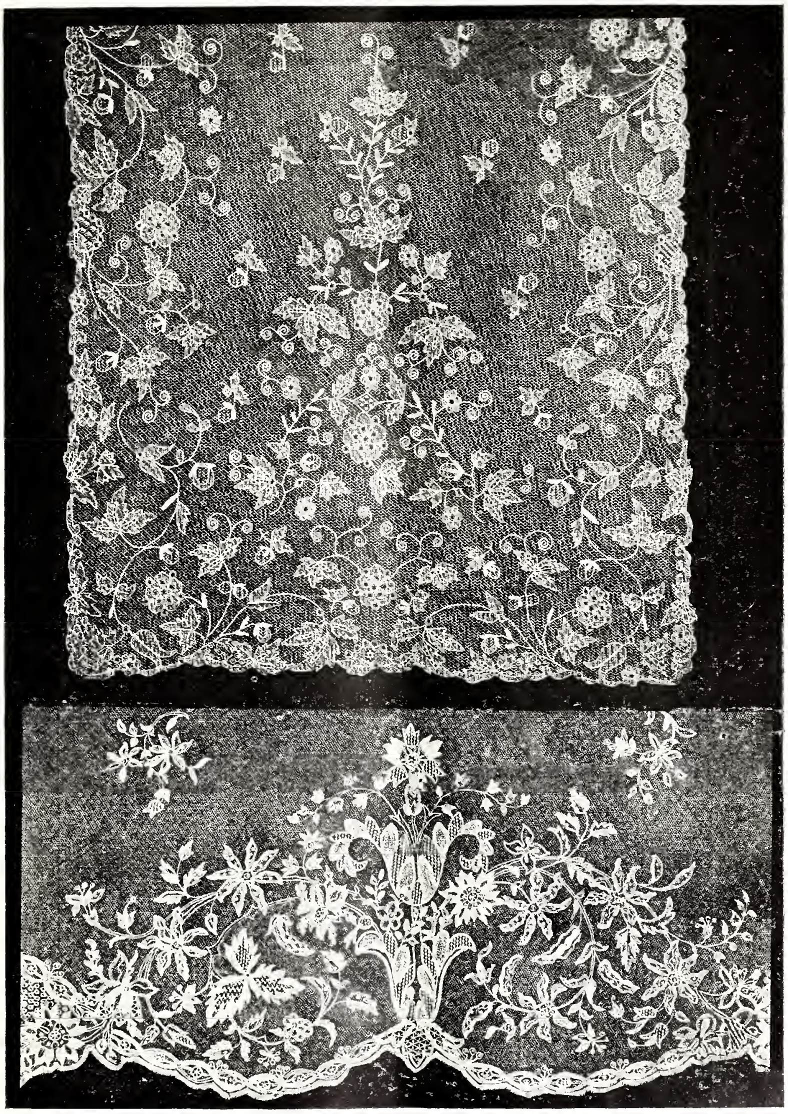
The last ten or twelve years have seen a marked revival of many of the old handicrafts, which had fallen to decay through the substitution of machinery for every variety of hand labour. A reaction has set in, during the past decade, in those branches of labour where manual skill and individual intelligence can never be entirely replaced by mechanical contrivance, and in no field has this reaction told more extensively than in lace-making. Fifteen years ago English lace was almost extinct; to-day it is a recognised industry.

So much has been written on the subject lately that it is unnecessary to describe the origin and history of lace-making in this country, it is sufficient to remind you that there are only two distinct types of fine English lace, both of which belong to the Flemish school. Devonshire lace, commonly called Honiton, which is, both pillow and point, of the same kind as Brussels, and the lace of the Midlands, generally known as "Bucks point," which belongs to the *genre* of Mechlin, Valençiennes, and Upper Flanders. Besides these, some tambour work is to be found in Essex, and various coarse laces, such as torchon and Maltese, are made alongside of the fine, in the same districts. This is the case in all lace-making countries, the coarser varieties representing the lower grades of skill in lace craft. They are of little value artistically, and are frequently a source of deterioration to the industry as a whole, but that is a point I must illustrate later. The lace revival is chiefly concerned with the two principal varieties already mentioned, and has taken place simultaneously in the old centres of the industry, East Devon, with the neighbouring districts of South Somerset and South-west Dorset; and that part of the Midlands that includes the north of Oxfordshire and Bucks, with the adjoining districts of Northamptonshire and Bedfordshire. Its history is much the same everywhere. Sometimes singly, sometimes in groups, as small societies or associations, those interested in English lace set themselves to promote and improve its production by supervising the work, supplying good designs and materials, and by obtaining a sale for the lace that would ensure sufficient wages to the workers. These enterprises were, in the first instance, purely philanthropic, for the industry had sunk to a level at which it had almost entirely ceased to attract commercial investment. But from very small beginnings, the revival grew; between 1897 and 1904 a good deal was accomplished, a steady, though limited, supply of really fine work was established, and secured its market. Since then, within the last four years, a very noticeable advance has been made. It may be measured by the numbers that the industry employs, the improvement in the texture, quality and design of the lace, and by the rise of the lace-makers' wages. The slides now shown illustrate three typical pieces of Devon lace, the first a collar made in 1830, three specimens of recent work and the sprigs used in Devon lace. Then we have three representing the fine lace of the Midlands, and one to show the Essex tambour work which closely resembles Limerick.

To take the first point, it is very difficult to obtain exact figures, but to quote typical instances, Miss Audrey Trevelyan tells me that she started work in Beer and Branscombe in 1894 with a mere handful of old workers; she has now 80 in the former, and 60 in the latter village, not counting children. The North Bucks Lace Association in 1897 collected with difficulty fifty lace-makers of whom the majority were over sixty years of age, in 1902 there were about 200, many of whom had been reclaimed from making coarse lace. This year there are over four hundred workers of fine lace employed by the Association, of whom at least half are young women and girls and another 25 per cent. middle-aged workers who had learnt in their youth and have now taken to it again. It is estimated that "Bucks point" gives employment to upwards of fifteen hundred workers in the Midlands, for besides the N.B.L.A. there is a similar society in Northamptonshire, and six or seven "free lances," who employ from 100 to 150 workers each, such as Mrs. Harrison, at Paulerspury, Miss Sivewright, at Thame, and Miss Burrowes, at Buckingham. The local dealers also take a little fine lace, but very

little compared with what they buy of the coarse varieties. The number of workers increases steadily, and will continue to do so, for all through the Midlands the women are teaching their children to make lace, and this, in my opinion, is the most significant feature of the movement. It was a matter of great difficulty, even as lately as 1902, to get the children to learn to make fine lace, even when classes were provided by the Associations, or by the County Councils at their instance. During 1902 to 1904 the Bucks County Council provided lace instruction at Stony Stratford and Newport Pagnell, but the attendance was small and irregular, and the classes have since been discontinued. At present the Oxford County Council provides lessons at Wheatley for a class that consisted last year of nineteen pupils. A lesson of an hour is given once a week during nine months of the year. This is the only instruction in lace provided by public money that I can hear of in three

Fig. 1.*

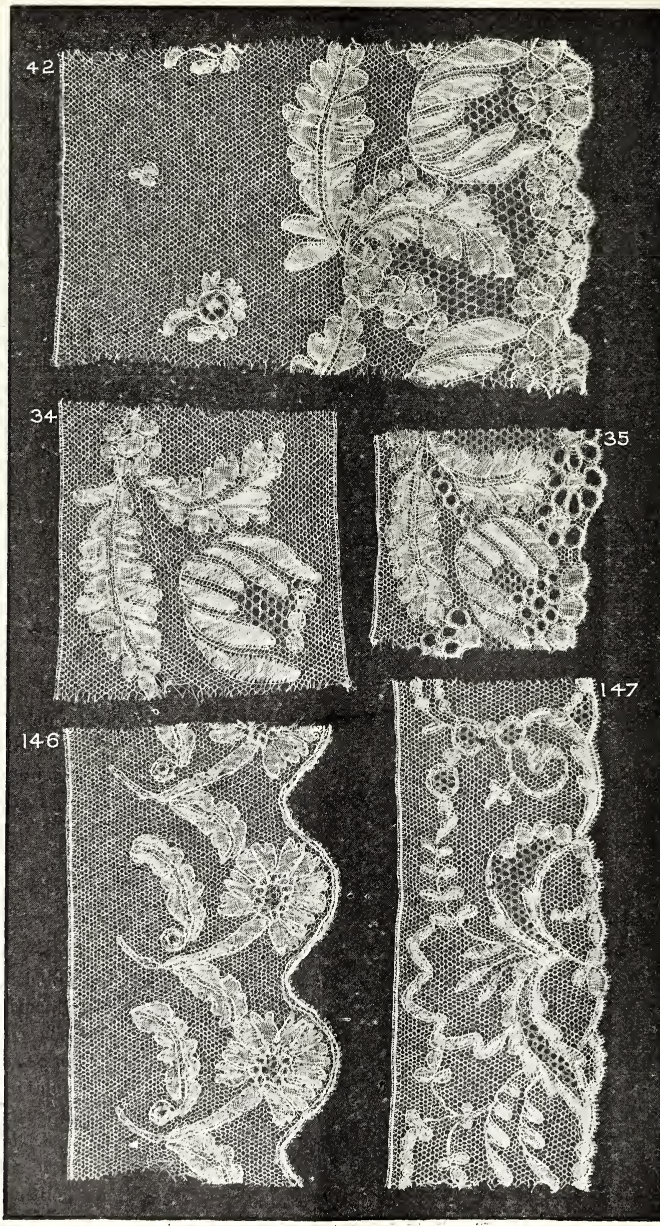


Limerick Run and Tambour.

* Figs. 1 and 7 are reproduced by the courtesy of the directors from the Catalogue of the "Daily Mail" British and Irish Lace Exhibition; and the blocks of Figs. 2 to 6 and 8 are kindly lent by the North Bucks Lace Association.

out of four of the Midland counties, and I must say that elementary instruction in lace-making limited to one hour a week, is simply waste of time and money. If the lesson is in the higher grades of lace-craft for advanced pupils it might be of service, but it is as futile to try to train a child as a lace-maker as it would be to expect her to become a professional pianist, with one lesson of an hour in the week, and according to the letter of the educational law, that is all a County Council is permitted to give to children of school age. If a girl is to become a good lace-maker, if she is to earn anything appreciable, she must be taught quite young, and practise the work every day under supervision, otherwise it is impossible to acquire the skilled touch on which the quality and value of the lace so

Fig. 2.

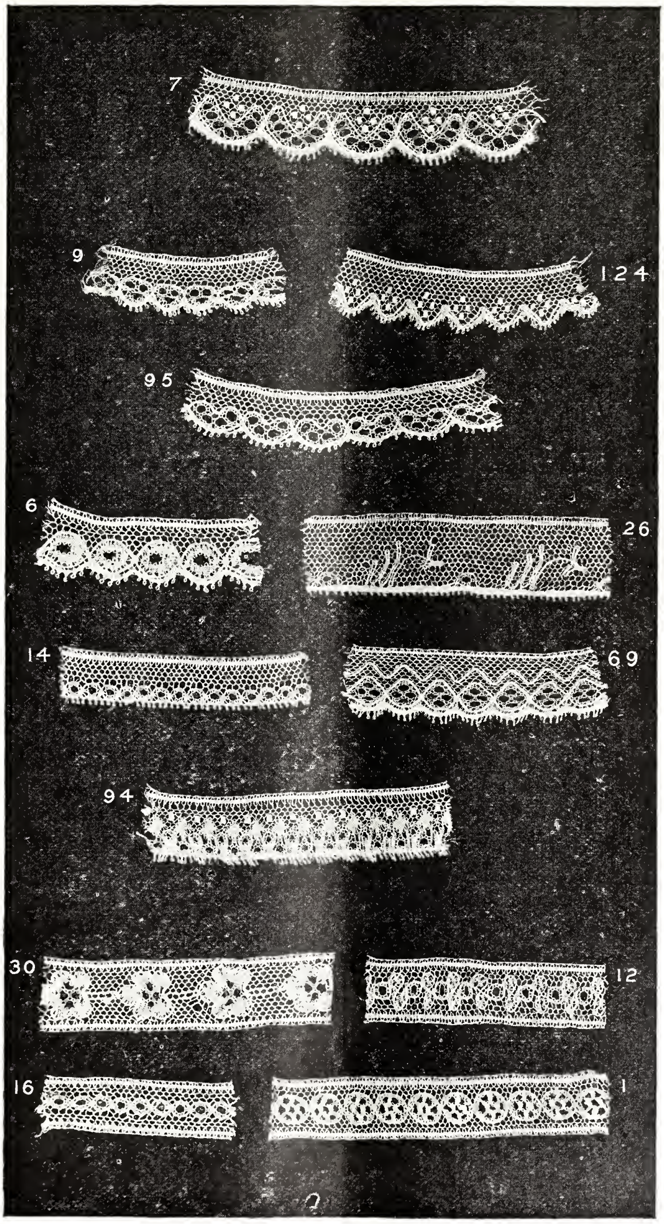


Bucks Pillow-point (the first three show the tulip pattern).

largely depend, or the speed, without which her earnings would be infinitesimal. It is far more satisfactory from every point of view that the lace-makers should themselves teach their children; as far as manual skill is concerned, the result is better and much more likely to be permanent, and it tends, moreover, to quicken both the parents' sense of responsibility and the child's interest in home that State education does so much to destroy.

Bedfordshire is an exception among the Midland counties, in that its County Council actively aids the lace industry. The conditions of the industry in this county have been slightly different, for its trade in cheap coarse laces has been brisk for

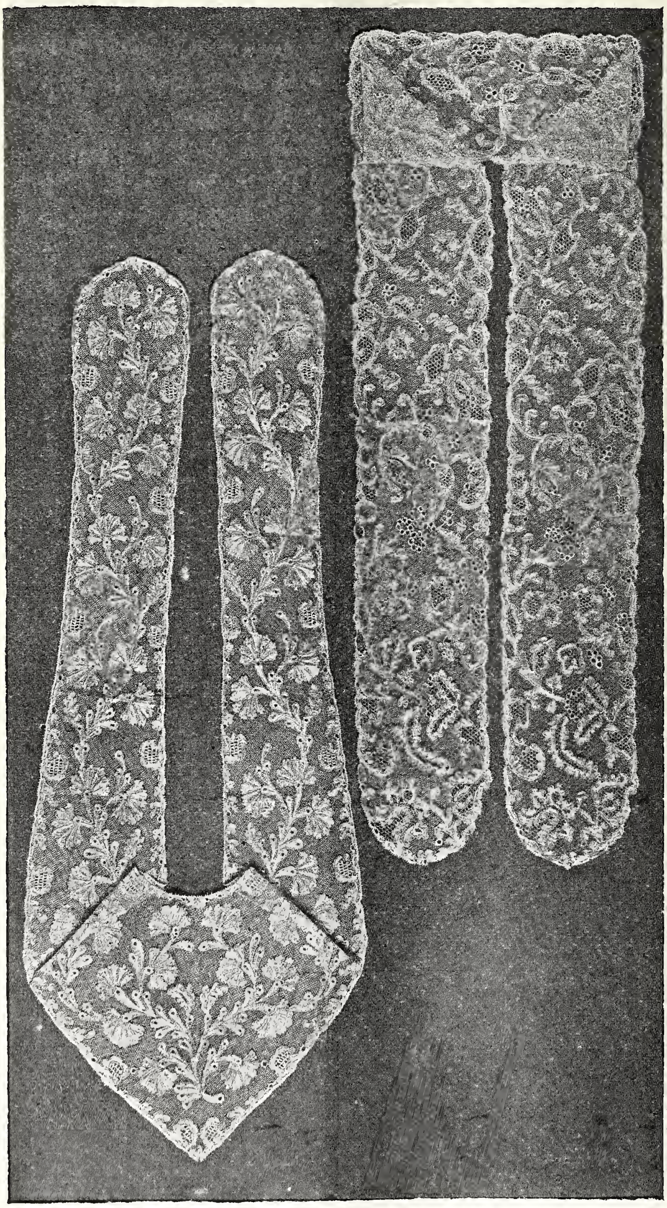
FIG. 3.



NARROW EDGINGS AND INSERTIONS OF MIDLAND LACE.

many years with the result that Bucks point was even more completely extinguished here than in the neighbouring counties. It was not until 1903, when the revival of fine lace in Northamptonshire and Bucks began to attract general attention, that efforts were initiated to restore it also in Bedfordshire. An Association was formed, affiliated to the N.B.L.A. and the latter lent the help of its organisation, and supplied teachers and patterns, in return for an annual subscription to the general fund. Recently a Lace Education Committee has been formed under the auspices of the Beds County Council, which is entrusted with £50 a year to expend on lace instruction. During the last six months classes have been started in various villages, and Lady Mackenzie, chairman of the Com-

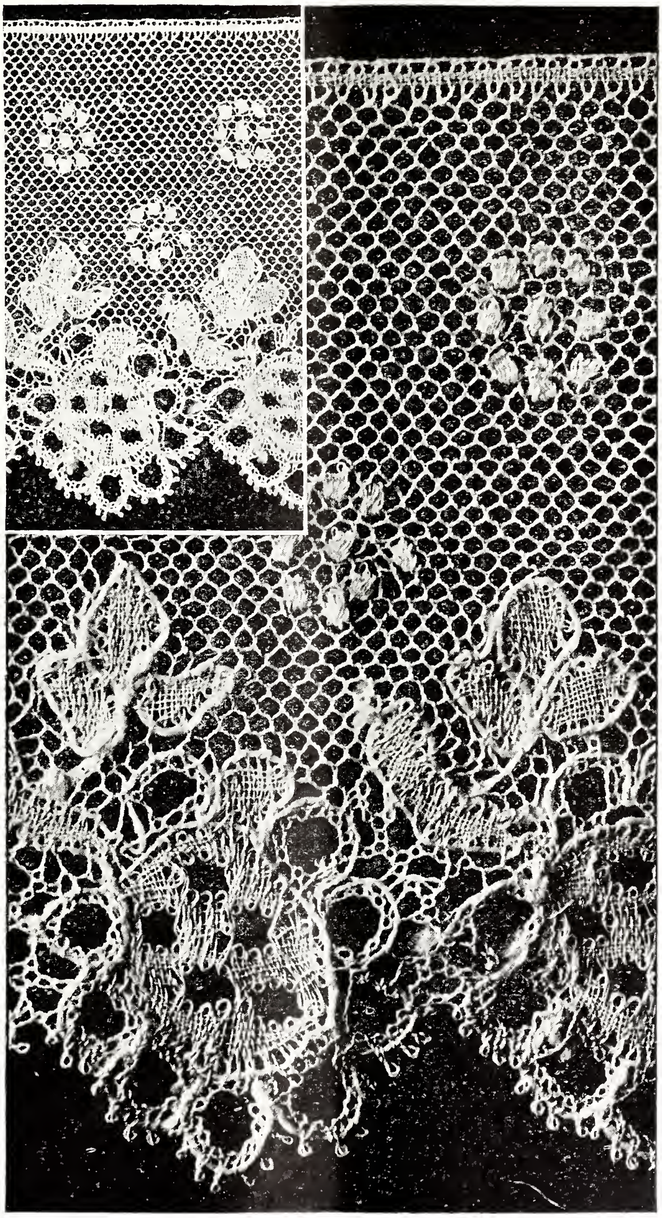
Fig. 4.



Scarves in Bucks Lace.

mittee, informs me that there are many more applicants than can at present be provided for, as teachers are scarce, and also the classes are strictly limited in the number of pupils on their own account; Lady Mackenzie herself has a class of seven little girls at Tempsford. It is too soon yet, of course, to show results, but much may be hoped for in time.

Fig. 5.



Bucks Lace, enlarged to show Threads of Edging and Lace. (Natural size in corner.)

taken, the first lessons being given to only two at a time, and the number gradually increased as progress is made, but finally limited to twelve. To prevent disappointment several ladies have volunteered to give lessons

A propos of the difficulty of obtaining teachers, the established industries have received during the last two years an ever-increasing number of requests for teachers and patterns that they are quite unable to meet. These

requests come from all parts of the country, and even from India and America, but foreign demands are naturally refused; the English industry cannot afford to create prospective rivals.

In Devonshire, also, the children are beginning to be taught at home, but the Devon County Council has done a great deal to encourage the work and supplement private instruction. It provides teachers for classes twice a week, of two hours each, at Branscombe, Bicton, Woodbury, Awliscombe, Broadclyst, Sidbury, another village of the name of Woodbury, where the second lesson lasts three hours, and once a week for two hours at Belstone and Sampford Courtenay. Both children and women attend these classes; the pupils number on an average eight at each place named, except Awliscombe, where there are nine.

The Somerset County Council gives no grant for lace instruction, but has offered this year to remit the fees of the six best workers in the lace class at the Taunton School of Art. This class, started in 1902, by members of the school, works only from new and original designs prepared by the teachers, who are all prizewinners in the national competition, and it has produced some very good work.

Beyond the two principal centres of the lace industry, very little lace worthy of notice is made as yet, though the rise of lace-making has induced attempts to establish it in other parts of the country, such as Lady Thiselton Dyer's Industry at Witcombe, Gloucestershire, the Winchelsea Industry in Sussex, both of which work Bucks point; and the Honiton Settlement (for which workers were brought in from Devonshire in 1901), at Diss, in Norfolk. This last-named now employs fifty locally-trained workers, and has twenty children under instruction, but is obliged to limit its numbers as the sale of the lace is uncertain. The Norfolk lace is very fair, but cannot as yet compete with Devon lace. Heredity has a very definite value in lace-making—where the craft is indigenous valuable work is produced with much less time and trouble than where it is introduced as a new form of labour. At Malmesbury, Warminster, and Downton, in Wiltshire, efforts have been made to revive the local lace, which I can only describe as a degenerate form of Bucks point, or a cross between that and torchon. At Malmesbury, Lady Suffolk has established a lace school. to which are now attached 37 workers; at Downton gratuitous teaching is given privately to a class of about twenty young girls, between the ages of ten and sixteen, and there are perhaps as many older workers scattered about the out-lying hamlets.

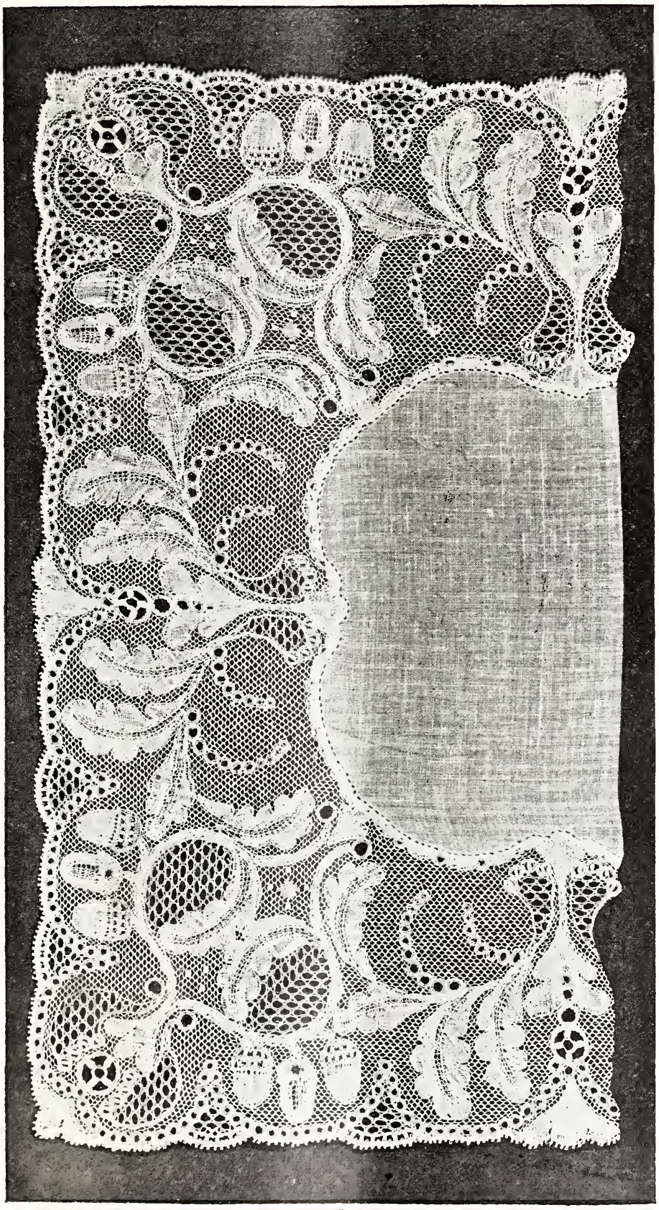
There are also two entirely foreign forms of lace that are made, each in a small isolated district, from which neither has spread: the French tambour lace made at Coggeshall, Essex, that employs from fifty to sixty workers, and the thick linen lace of the Milanese type that is produced at Winslow, and a few neighbouring villages in Bucks, under the direction of the Hon. Rose Hubbard, by 150 women and girls. Point lace, that is needle-point, has practically disappeared. A very little of inferior quality is made in Devonshire, but it is so badly paid, and so injurious to eyesight, that it is only to be obtained nowadays from convents.

The improvement in quality and texture of English lace is due largely to the improvement in the materials used. During the nineteenth century cotton came to be used everywhere (as it still is used in Belgium) in the place of linen thread, and at first the manufacturers refused to attempt to supply fine flax thread, saying that the demand for it was not sufficient to repay them. But as the demand came by degrees from several quarters, the thread was made, and during the last three years special attention has been given to the subject. Two Irish firms in particular now supply fine thread of excellent quality, and the difference it makes in the texture of the lace is very noticeable. It now bears comparison, in this respect, with the sixteenth and seventeenth century lace, which was of course made always of linen thread. In the same way cardboard had been substituted in the Midlands for parchment, by reason of its cheapness, and the restitution of the old material, which is much firmer as a foundation to work on, has only been gradually achieved. These may seem trifling matters, but the use of proper materials affects not only the texture of the lace, but also the worker's touch, on which the beauty and value of the lace so largely depend. From these we come to the all-essential matter of design, and here it must be confessed, although some advance may be shown, is the weakest point of the modern lace industry.

I have been reading, with very great interest, a paper on this subject written by Mr. Alan Cole for this Society four years ago. He complained of the general poverty of modern lace design, and of the habit of using for it only certain stereotyped forms and fillings; he

spoke then only of Devonshire lace, but his criticisms apply equally to other varieties, and are still to a great extent just. He pointed out the advisability of procuring professional work for this department of the industry, of having patterns prepared by trained designers, as is done on the Continent. In Belgium, and also I believe in Ireland, every lace dealer of any standing employs a designer who works for him exclusively, but it must be remembered that design is the most skilled and the most costly branch of the industry, and therefore the first to be neglected in time of depression.

Fig. 6.



Miss Delves-Broughton's Prize Design, 1904.

Until it is definitely profitable to design lace, it is not to be expected that professional skill will be devoted to it, and as yet the lace industry in England has been able to afford comparatively little. But even that little

shows progress in the right direction, and material help has been given by the Board of Education in offering prizes in this section of design in the annual national competition. In 1903 the gold medal was won by Mrs. Mason, then a student, now a teacher of the Taunton School of Art. Her services were subsequently obtained by Miss Trevelyan to devise the lace to be exhibited by the Beer and Branscombe workers at the St. Louis Exhibition, where it took the Grand Prize.

The Taunton School of Art, as I have already mentioned, devotes special attention to the subject of lace, and its students have been noticeably successful in the national competitions, carrying off the gold medal in 1903, the silver medal in 1904 and 1906, besides smaller prizes every year for the last ten years in the section of lace design. The gold medallist of 1904 was Miss Delves-Broughton, a student of Battersea Polytechnic, and her successful design shown on the next slide (Fig. 6) was bought and carried out by the North Bucks Lace Association. This lady has since undertaken all the new designs required by the Association, besides several for the Paulerspury industry, and the lace made from her patterns has taken prizes in two succeeding years at the Albert Hall Exhibitions of Home Arts and Crafts, and several provincial exhibitions. A wide flounce of her designing has only recently been completed in the finest hand-woven linen thread, and is being exhibited in London. I may add that since her marriage, three years ago, she has given her valuable services free.

Besides new designs, many characteristic old patterns have been reproduced and adapted to modern fashions in the Midland industry. Bucks point is, by its nature, less variable than Honiton, and much that is of value has been found among the parchments handed down as heirlooms in lace-making families. For instance, the tulip-pattern, a standard design, perhaps three hundred years old, has been adapted to collars, scarves, and berthas, besides its permanent use as a flounce or insertion. In this again, it is most important that expert opinion should decide what to use, and what to discard.

Of late years English lace has gained recognition abroad, Miss Trevelyan's workers have been awarded the Bronze Medal at Chicago, Silver Medal in Paris, Grand Prize at St. Louis, and the Diplôme d'Honneur at Milan, the last for a copy of an old Italian design.

But foreign tariffs shut out English work almost entirely, so that we must look for a market for our home products within the Empire, and in this the home exhibitions are most useful. Within the last fifteen months English lace of good quality has been shown at the Albert Hall Exhibition, and at those of the Artists at Work (London and Glasgow), Amateur Arts (London and Brighton), and a large Lace Exhibition, organised by the *Daily Mail*, in London, also at Edinburgh, Newcastle, Bristol, Winchester, Aldeburgh, Lowestoft, Tunbridge Wells, Bishopsgate, Blessingbourne, and Luton; and at Christchurch (New Zealand), not to mention the many smaller ones in the provinces, especially in the lace districts.

These exhibitions of handicrafts are of distinct value to the lace industry in arousing wholesome competition on the one side, and public interest on the other. They serve also to educate the public taste, which in all branches of art is somewhat indiscriminating. One great difficulty that the promoters of lace as an art have had to encounter is that a large section of the public that buys, is absolutely ignorant as to what is good or bad, and merely wants something showy and cheap. But here genuine philanthropists have done good service, for they recognised that to re-establish the lace industry on a secure footing they must satisfy, not the ignorant buyer, but the connoisseur; they did not seek, as the small trader must, immediate and pecuniary profit, but were content to look to the ultimate benefit of the workers. In this connection it is worth while to note what has happened in Belgium in the last ten years. While the English industry has risen, that of Belgium has deteriorated. A decade ago quantities of fine pillow lace were made in the districts round Brussels, though the miserable wages—half a franc for a summer day's work, out of which materials had to be paid for—discouraged the rising generation from lace-making. In 1895, attracted by the cheapness of the supply, various English dealers placed agents to buy up the lace, and gradually whole villages came to work exclusively for them. They wanted lace in quantities, and were not in the least particular as to the quality; the natural result was that fine work was speedily discarded; to the great discomfiture of the Brussels lace-dealers who have, on the Continent, more especially in Paris, a critical *clientèle*. Lately, a leading Brussels dealer, and also the buyer for one of the most important cosmopolitan

houses, has told me that, except for convent work, the end of the supply of fine *duchesse* (pillow Brussels) is in sight. Through the short-sightedness of the dealers who underpaid the work, the industry has been exploited by those who cater for a vulgar demand, and, as an art, destroyed.

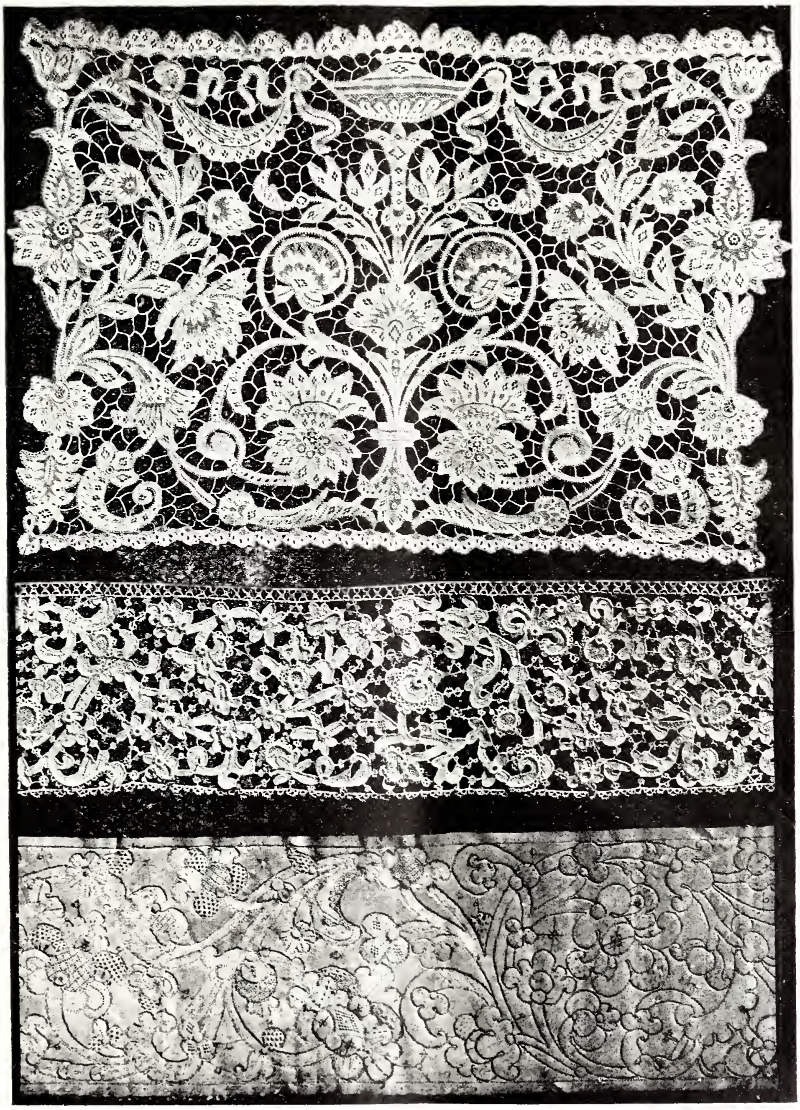
There is always the danger of the same thing happening in England unless the industry is directed by persons who recognise the merits of its artistic as well as of its commercial side, and possess sufficient knowledge and influence to guide its patrons. Cause and effect are bound up in an eternal circle, the relation of skill in work to rate of wages, and of wages to demand, act and react, one upon another. The standards of skill, in the classes that supply, must depend, ultimately, on the standards or taste among the classes that demand, but standards of taste can be largely influenced by the middleman.

FIG. 7.

1

2

3



1. Irish (Youghal), flat needle-point. 2. Irish (Innishmacsaint), raised needle-point.
3. Parchment Pattern.

I have only referred incidentally to the lace-

makers' earnings. The rate of pay has risen from 1d. an hour, at which it stood for the last thirty years of the nineteenth century, to 2d. an hour, while highly skilled work is slightly

Fig. 8.

A Lace-Worker and her Pillow.

better paid. Lace-making is so entirely a cottage industry, and so largely a married woman's trade, that it does not engage the worker's whole time, and the earnings remain for the most part a supplementary, not a living wage. Probably eight out of ten workers do not earn more than 7s. a week, many only make 4s. to 5s., though I have known exceptional cases where highly skilled lace-makers, by devoting all their time to the pillow, have earned 12s. to 15s. a week, but this means ten hours work a day, sometimes more. Wages have not increased in proportion to the increased demand for English lace, and this is chiefly because of the ruinous competition to which the industry is exposed,

through convent labour. The competition of the cheap Belgian work is surmounted by the superiority of the British work, but convent lace, both Continental and Irish, is a serious obstacle to any rise of wages. These communities, that are factories and retail houses in one, have a minimum of working expenses, and a practically unlimited supply of unpaid, or almost unpaid labour. Many convents that trade in lace and fine needlework take in foundling girls and bring them up to one branch of work only; they become very highly skilled in that one branch, and often work simply for their keep, which costs an endowed community very little. The result is that the work is sold at prices that undersell outside labour, while it affords an almost clear profit to the convent. Several of these lace-making convents, expelled from France, have settled in England, and I know of more than one in India, while there are many in Ireland. They constitute a very serious danger to the English industry and one that is likely to increase.

The next slides show the beautiful needlepoint made at Youghal convent, after which we have pictures of lace-workers of all ages.

The industry stands in a peculiar and somewhat artificial position; its production is largely stimulated by private and disinterested efforts, its trade is divided between small provincial dealers on the one hand, who find a ready market for cheap, inferior work, but are, with few exceptions, frankly ignorant of lace as an art, and philanthropic and artistic enterprise on the other, which, regarded from the strictly commercial point of view, has so far carried on business at a loss. Between the two there are certain ladies to be reckoned with who dabble with the industry to supplement their incomes, and mix up philanthrophy and trade in inextricable confusion, to the detriment of both. For as they do not depend on lace-dealing for a living they are content to take a smaller profit than would be necessary for ordinary business, but since they wish to make a profit they economise over materials and designs and tend to keep both work and wages at a dead level. The lacemakers have little choice of a market, and are incapable of combining amongst themselves; their beautiful craft stands perpetually between the devil, in the shape of the speculative dealer, and the deep sea of oblivion, and only public appreciation of its value can make its precarious position secure. Like all skilled handicrafts, it represents, not merely the addition of a few shillings to the weekly earnings of working people, but the love of beauty, the joy and honest pride in work of many generations past and gone; it affords a better school for those same refining qualities than most of the occupations opened to the wives and daughters of agricultural labourers by free education.

I should like to see a national Lace Guild in England, that should uphold the standards and best interests of the industry, while relieving it of the disproportionate trouble and outlay so often attendant on the sale of the lace. I am not at liberty to quote financial details, and indeed they would be out of place here, but there is no doubt that the small trader is almost inevitably parsimonious in his methods, while the amateur in trade is inevitably wasteful, and there is also no doubt that the lace industry is not yet strong enough to flow through the ordinary trade channels. It will not, as prices go, bear more than one profit, and that profit, unless economy is effected, will not suffice both for ordinary working costs and for expensive æsthetic advance. A Lace Guild might meet the situation, and enable the recovered industry to stand alone, and to keep an honoured place through many future generations.

[The paper was illustrated by a series of lantern slides, specimens of Devonshire, Buckinghamshire, Northamptonshire, Suffolk, and Essex laces, lent by the Board of Education. Also by further slides of Buckinghamshire and Irish laces.]

DISCUSSION.

The CHAIRMAN (Mr. Alan S. Cole, C.B.), thought the Society was much indebted to Miss Isemonger for her most interesting paper, the slides and the specimens of work with which it had been illustrated making what she had said all the more real. Miss Isemonger seemed to think that the teaching of lace-making, as at present carried out in elementary schools, was useless, but he was not quite sure about that himself. Since 1902 the nation had become possessed of local education bodies, which could be called upon to give suitable teaching for the particular districts with which they were concerned. He apprehended that if the local education authorities in, for instance, the Midlands, Devonshire, and Somersetshire, knew what was wanted, they could easily initiate instruction in lace making in a most useful way, and provide for three or four hours' instruction a week being given instead of one, as appeared to be the case in the

exceptional instance referred to. He was placed in rather a difficulty in speaking on the question of elementary schools, because he was an official of the Board of Education, but he did not think he would be exceeding his privileges or his restrictions if he referred to the introduction to the code of regulations for elementary schools which the Board issued, in which it was specifically stated that the elementary school was intended to develop the manual dexterity of children as well as their intellectual ability, in fact it was to cultivate the hand and the eye as well as the mind. He could quite imagine that in the lace-making districts the cultivation of the hand and the eye might be as important as the cultivation of the child's capacity to know history or to be able to recite Milton, but it was a delicate question for him to discuss, and he would much prefer that the people who were interested in lace-making in different districts should go to their own education authorities, and impress upon them what it appears could be done, even under the present regulations, which were probably not so restricted as had been hinted, since it was possible to read a good deal of freedom into them. Lace-designing was not in a very high state of perfection in England, although it was better perhaps than it used to be. Miss Isemonger seemed to think that lace-making was nearly extinct in England fifteen years ago. On the contrary, he should have said that it was beginning to revive at that time, and that it was very nearly extinct thirty or forty years ago. Amongst those who had been very much interested in forwarding the education of people in taste and in fostering Irish lace-making industry were a few Irish Members of Parliament, who in 1883 went to the Science and Art Department at South Kensington, and asked that office to do all they could to help. At the instance of Mr. Mundella, the then Vice-President for Education, he went over to Ireland, and lectured as best he could on the question of designs in the different schools and towns where lace-making was in vogue. After that his duties increased, and he was called upon for the twelve years following to go round to almost all the convent schools and other centres where lace was made. Again, in 1887, he inquired into and reported on Devonshire lace-making, his report being laid before Parliament in the following year. In 1891 he reported upon lace-making in the Midlands. Hence therefore in that connection he desired to make this slight correction of Miss Isemonger's statement with regard to the date of the revival of lace-making in this country. Again, he wished to point out that so far as he knew, very few Irish convents were at all concerned with foundlings, the majority of them dealing with adult lace-workers, who were helped very much by being given good designs, and also by being taught how to draw and make tracings. An important upshot of the movement in Ireland was that the Royal Dublin Society, which was a very active body indeed, established some ten years ago a scheme for annually awarding prizes for all sorts of lace-making, a definite statement being made of the kind of lace which should be submitted to compete for the prizes. That had had a most important influence on Irish lace-making, because the Dublin Society had had the advantage of the advice of gentlemen engaged in trade, who were able to tell them what the changes of fashion were likely to be, and what sorts of lace should be produced. For several years he had taken part, in connection with experts of the trade, in awarding these prizes for laces, and it had been most interesting to notice how Irish lace had developed in tastefulness and along trade lines, with, he believed, great advantage to the workers so far as wages were concerned. Nothing of that kind had been done in England. The writer of the paper had mentioned the National Competition, but that was absolutely restricted to students of the schools, Schools of Art, and classes which received grants from the Board of Education. The prizes offered at the National Competition were not offered specifically for lace in the same way as the prizes of the Royal Dublin Society, while the programme of the prizes of the Home Arts Association was a little vague compared with that of the Dublin Society, which had exercised an educational and effective control over the work in Ireland. Design was bound up very much with what a nation was or had been accustomed to do. He believed it to be the fact that France must for some time to come always be ahead of this nation in that respect, because she had such great traditions in taste maintained through her schools of designs. Colbert, Louis XIV.'s Chief Minister, initiated a Lace Making Company with the help of State subsidies, and encouraged the industry wherever it was suitable. The people who became proficient as lace-workers received, through the Company, designs made by competent and distinguished artists who had passed through the old *Ecole des Beaux Arts*. The influence of that school had percolated through all that had been done in France in the way of lace-making. Many connoiseurs did not like the style of Louis XV., but the drawing and composition to be observed in the more important lace of that time were of high-class ability. Instead of a National Company and State subsidies, Miss Isemonger's proposed National Guild, working hand-in-hand with the public forces that it could operate upon, such as local education authorities and associations stood, he thought, a very good chance of performing great good for the lace industry in England.

Mr. ARTHUR BLACKBORNE thought that as long as English people did not have good designs for lace-making it would be impossible to make the product a commercial success. The old Italian and French people used to pay hundreds of pounds for fine designs, and the sooner the best artists in England were encouraged to become lace-designers the better it would be for the industry. The designs of many artists were absolutely useless to the lace-maker, because they displayed a lack of knowledge of the requirements of the trade. Fine designs were

often made on paper, but it was impossible to interpret them into lace. Miss Isemonger had referred to Bucks point lace, but as a matter of fact Bucks lace was made on a pillow, and was quite distinct from point lace. The point was only used for lace made with a needle. He quite agreed with the statement made, that instructing children in the schools for one hour a week in lace-making was useless. To be of any value the instruction must be continuous. Belgium had retained her supremacy in lace-making owing to the convents, the sisters of which took more pains in instructing their pupils than almost any other institution. It was the practice of the trade at one time to support particular convents by buying all the work they turned out, but this had been given up lately because inferior lace was then sometimes made which it was impossible to sell. If convents and schools were encouraged to produce good work, he thought the lace-making industry would be benefited. He thought it would be a practical outcome of the meeting if a resolution in favour of the formation of a Lace Guild were passed, because in that event many wealthy ladies would join the movement.

Mr. T. ERAT HARRISON said that lace-makers frequently complained of the work produced by the designers, but he thought both parties were rather obstinate, and if they would only work together a little more, mutual benefit would result. He could not understand why some of the best designs which Miss Isemonger had shown were not applauded as some of the others were.

Miss CHARLOTTE BROWN suggested that if a guild were formed it should be worked on more conservative lines than most existing guilds. Modern guilds had fallen into disrepute because they were, more or less, fast and loose associations, which were not conducted on sound lines.

Miss KEWLEY said that one of the principal difficulties in getting good designs for Bucks lace was that the expense was so enormous. £2 or £3 had to be paid for quite a small parchment, and 30s. or 35s. for a correct copy of it. The sheep-skin used was also very bad and quickly wore into holes, probably due to the fact that it was now prepared by machinery instead of by hand as in old times. The parchment bill of the North Bucks Lace Association amounted to £40 or £50 a year, so that it was impossible to constantly renew designs owing to the great expense. There was only one worker in Northampton, Bucks, and Bedford from whom it was possible to get an absoluely correct design for a parchment; the people did not seem to learn now to reproduce the true pattern. A girl who wished to learn parchment pricking had to pay £25 to this worker for her lessons and live at her door for three months, and then she was not able to do difficult work. A woman to be a parchment pricker must thoroughly understand lace-making, otherwise she put in holes that were not required. The principal difficulties experienced by the Association were the great scarcity of good prickers and good skin, and the great expense involved.

Mr. FREDERICK VIGERS thought the first essential was to get money with which to carry on the work. In his opinion, if a few artistic people were approached, there would be no difficulty in obtaining the necessary funds so that a start could be made by obtaining a set of designs, from competent artists, from which beautiful lace could be produced. The ordinary modern lace was not ornamental for the person, nor particularly beautiful, and to go on making inferior lace from bad designs seemed to him waste of time. It had been suggested that designers who had not been accustomed to designing lace would not be fitted for the work; but if a designer was in the habit of seeing a good lace, or made a study of it, if he had fingers that could draw, he would soon produce proper designs. It was simply a matter of practice. Intelligent modern designers could easily make a study of the old lace, and pick up all the fine points connected with it.

Miss BARNES, speaking as a practical lace-maker, said that a person who designed lace must be a lace-maker more or less. Many designs had been sent to her by eminent designers, which it was absolutely impossible to use because the designers were unacquainted with the details of the industry. The designer must understand exactly the character of the lace he was designing, and know exactly where the patterns touched; but it took some years of practical experience to obtain the requisite knowledge; in fact, in a certain sense, the lace-designer must be a worker.

Mr. ARTHUR BLACKBORNE thought everyone agreed that it required skill to design lace. The only difference of opinion which existed between Mr. Vigers and the other speakers was, that whereas the former thought any artist could design lace, practical workers knew that a good lace-designer must have technical knowledge of the subject. If an artist studied the question for six or twelve months, he would be able to turn out good designs, but present-day artists would not devote their energies to the subject unless they were paid for it.

Mr. FREDERICK VIGERS agreed with Mr. Blackborne that the artist must, of course, study the subject, and that any design he produced must be useful for the purpose for which it was intended.

Miss PENDEREL MOODY suggested that the children in village schools who were taught lace-making should receive some instruction with regard to form and design, which at present was almost entirely absent from their teaching. Then as the children grew up and became competent lace-workers, they would have a fair knowledge of form and design, or at any rate an insight into the subject. If designs were then obtained from great designers, who perhaps had not made a thorough study of lace-making, these educated workers would be able from their own knowledge gained in lace-making to rectify any technical errors in the artist's design.

The CHAIRMAN, in moving a hearty vote of thanks to Miss Isemonger for her most interesting paper, said that although it was against the rule of the Society for the meeting to pass a resolution, he believed he was expressing the unanimous opinion of those present when he said that he thought it would be a desirable thing that a guild should be established to promote the interests of the lace-making industry in England.

The vote of thanks having been carried unanimously,

Miss ISEMONGER, in reply, thanked the audience for the very kind reception which had been given to her paper. With regard to the remarks that had been made, the National Lace Guild, the formation of which she had ventured to suggest, would naturally uphold the best traditions of the industry in regard to design, and try to restore it to what it was in its palmy days, when great artists thought it worth while to make designs, and the workers were very highly skilled. But of course the root of the question was money. Unless very skilled work, both in design and handwork, could be paid for, the best lace naturally was not produced. Before the audience dispersed she hoped they would carefully inspect the exhibits shown, amongst which was some Devonshire lace sent from two different centres, and also some specimens of the Devonshire lace that was made in Norfolk. Among the Honiton lace that had been sent were devices adapted from old patterns, and one specimen of an absolutely natural design of a blackberry spray. There was also a specimen of the Essex tambour work, and a few of the heavy Italian laces made in the Midlands, in addition to a good collection of fine Midland lace which she alluded to in the paper as Bucks point, to which expression Mr. Blackborne took exception. The expression was a local one, and was used in the sense of being fine lace, and not at all in the sense of lace made by the needle. Only one specimen of Irish needle point lace was exhibited, because she had not dealt with the subject of Irish lace but only with the English industry.

HOME INDUSTRIES.

Railway Rolling Stock Construction. — British railway companies manufacture in their own shops most of the rolling stock, engines, plant, and machinery they require. Are they well advised in doing so? The question—one of very great importance to the companies concerned—is discussed by a correspondent of *The Times* (May 20), whose contention is that it would pay the companies much better to do as foreign railway companies do—that is, place the orders with private companies, and retain the shops chiefly, if not exclusively, for carrying on repairs, and for retaining the rolling stock in an efficient condition. In the United States a limited amount of train construction is undertaken, but most of the work is let by contract. According to the *New York Railroad Gazette*, twelve private firms of locomotive builders in the United States and Canada completed 7,362 engines last year, nearly 90 per cent. of which were for domestic use, and quite recently the establishment of large locomotive works at Montreal was decided upon. In Germany, a single firm claims to have built 6,783 railway engines, of which 71 per cent. were for German railways. And it is the same with France, Belgium, and other industrial countries. The United Kingdom is the only country in the world in which railway companies constitute themselves wholesale manufacturers. What are the special circumstances that make it prudent and profitable for railway companies in this country to depart from the general rule? They are difficult to find, whereas the objections to the companies being their own manufacturers are many and obvious. It is not likely that the companies can manufacture as cheaply as outsiders. In the commercial world, as the correspondent of *The Times* points out, the specialising of manufacturing businesses is becoming more and more marked; competition has compelled not only the specialising of plant and machinery for individual industries, but the proper selection and training of men for the same purpose. According to the most advanced practice, it would be almost impossible for a firm of railway carriage builders to undertake the manufacture of locomotive engines, or *vice versâ*; or for a maker of signalling apparatus to build railway waggons. The nature of the work is so dissimilar, and the competition is so keen, that it would invite disaster. But a modern British railway shop is little less than a huge arsenal given up to the production of almost every kind of equipment and plant necessary to maintain the service. Amongst these are locomotives, carriages and waggons, points, crossings, signals, and other permanent way material. Some modern British railway shops also include steel works and rolling mills in their equipment. All these highly specialised trades are carried on by one man and his staff, few, if any, of whom have had any commercial training, and they are carried on practically under one roof, intermingled with a variety of miscellaneous work, and side by side with an immense volume of

repairing of all descriptions. There is not the incentive to competition, and the payment to those responsible is the same whatever the results. Then the system of costing is not likely to be accurate, and whilst a large amount of expensive machinery must be provided to keep up the demands of new construction, it can be kept fully employed only as long as there is work ahead. Railway companies are not immune from depression in trade more than manufacturers, but there is this important difference, that the private manufacturer is not confined to one market. When one is dull another may be active, so that there is reasonable prospect of fairly constant work; but with railway companies, when traffics decline, and stock is laid up, new work must cease, and the plant provided to deal with it must be wholly idle. The British railway manager will reply that by doing their own work the railway companies are able to employ cheaper labour, and to save the manufacturers' profit, but examination would probably show that the real cost of locomotives and carriages is much more than the market price.

Wool Packing.—A new process in wool packing, having for its object the exclusion of such foreign fibrous matter as twine and jute from the bales, is being tested in Australia. It was tried last month in presence of members of the Australian Wool Sorters' Association at a warehouse in Melbourne, and is said to have given satisfaction. Under this process packs with specially prepared "heads" and loose tops are used. After the bale is pressed the "head" is firmly secured to it. The chief feature of the system is that no twine or string can enter the bale, the only stitching necessary being on the two outside flaps. There is also a saving of twine, and another important feature is that by simply cutting the stitching on the two outside flaps the bale is ready for inspection by the wool buyer.

Metal Buttons.—Opinions differ a good deal as to the Territorial Army and its future, but one industry has good reason to be thankful for its creation. The Volunteers wore dark metal and white metal buttons upon their uniforms; the Territorials will wear yellow metal buttons, and the Birmingham button factories are just now busily engaged in executing War Office orders. It is, however, urged that the present rush and overtime in the trade might easily have been avoided, since it might have been foreseen that the Territorials would require buttons on their uniforms, and employment in their manufacture might have advantageously spread over many dull months instead of being concentrated upon a few weeks. Be that as it may, the fillip must be welcome.

Home Trade Contracts.—There seems to be a strong and general feeling of dissatisfaction just now amongst manufacturers with the methods of home trade buyers. The complaints are directed not against the probity of individuals but against a loose practice that has become almost a custom of the trade. It is alleged to be very common amongst home trade buyers to order something like a maximum season's supply beforehand, and then, if the season's demand proves disappointing, to neglect or refuse to take delivery of the full quantity bought. One correspondent writes to say that because last year his firm would not give full delivery of certain lines of goods it had about fifty claims from home trade houses to settle on account of non-delivery. Now the firm has on the contrary on order from these same firms an average of 1,000 pieces each, of which they have taken delivery of perhaps an average of 300 pieces, thus leaving a heavy stock of which they refuse to take delivery, although the goods have all been ready for several months. Another correspondent says his firm has over £4,000 worth of stock for home-trade houses, all due by legal contracts, January to April, and are absolutely unable to force delivery unless they go to the Law Courts, a course both unsatisfactory and expensive. The suggestion has been made that Chambers of Commerce should take the matter in hand, and draw up a common form of contract for use in the home trade, definitely fixing the final date for the completion of the transaction. But there are difficulties in the way of hard-and-fast contracts strictly expressed between buyer and seller. Where provision has to be made months ahead for a season dependent upon the weather there must be a large percentage of waste and loss in the marketing of goods subject to change of fashion, and some system would seem to be wanted by which this inevitable loss should be borne in equitable proportions by producer, distributor, and retailer.

Railways and the Public.—The affairs of the railways are a good deal in view just now. The movement in favour of nationalising them has brought into being a society to promote this great change. An executive committee has been formed, which includes several members of Parliament, and this committee has issued a circular, in which it says it hopes to bring about the change by means of (1) inquiries and investigations here and abroad, and arranging for national and international correspondents; (2) the establishment of branches wherever possible; (3) the publication of literature; (4) the holding of meetings; (5) the delivery of lectures; (6) the organisation of debates; (7) and by taking advantage of every opportunity to call public attention to the transit grievances of traders, farmers, and the community. To carry on this propaganda the society seeks to raise funds by annual subscriptions and donations of members. Another section of the public, railway shareholders, content with the present private ownership, but ill-content with the management of the companies, has formed an Association, to be known as the Railway Shareholders' Association, which proposes to call a conference of railway shareholders for the end of June. The aim of the conference will be "to bring all sections of the railway

world to a better knowledge of each other, and a better understanding of each other's claims." Representatives of the various interests connected with railways—traders, employees, &c.—will be welcomed, and specialists in various branches of railway economics will be invited to read short papers, and to take part in discussions.

GENERAL NOTES.

Portraits of Members.—Messrs. Maull and Fox have for some years taken photographic portraits of members of the Society, and they have lately presented the Society with a series of these portraits up to date. Messrs. Maull and Fox have expressed their willingness to take photographs of the members of the Society gratuitously and to present a copy to the sitter.

American Society of Mechanical Engineers.—The semi-annual meeting of this Society will be held in Detroit, Michigan, from June 23rd to 26th. Papers on the conveying of materials, and conveying machinery, including belt conveyors, will be read. Among other subjects to be discussed, are "Clutches" (with special reference to automobile clutches), "Some Pitot Tube Studies," "Thermal Proportion of Superheated Steam," "Horse Power, Friction Losses and Efficiencies of Gas and Oil Engines," "A Journal Friction Measuring Machine," "A Simple Method of Cleaning Gas Conduits," "A Rational Method of Checking Conical Pistons for Stress," and "The By-Product Coke Oven." A lecture on "Contributions of Photography to our Knowledge of Stellar Evolution," will be delivered by Professor John A. Brashear, of Alleghany, Pa. Excursions will be made to manufacturing plants, shipbuilding yards, and various points of interest in and around Detroit.

Hops in California.—In California, as elsewhere, it is usually a feast or famine with hop growers. The market for no other staple is so easily glutted. The crop of 1907 was the largest on record, being estimated at 143,500 cwts., against 138,571 cwts. in 1906, and 113,750 cwts. in 1905. During the last three or four years a large hop grower of California has been experimenting on the production of a hop-picking machine, and in his report on the trade and commerce of the district (Annual Series, No. 3998), Mr. Consul-General Hearn says the machine was put into operation on a small scale in 1907, and proved very successful. A number of machines are now in course of construction, and will be used in harvesting the crop of 1908. The inventor expects that his machine will be introduced into the United Kingdom in 1909. A prospectus with an illustration of the machine will not be available until next year, but if experience proves that it will do on a commercial scale what is claimed for it, it must greatly affect the hop position in this country, since it will largely reduce the cost of harvesting crops, now such a very serious item in the expenditure of the hop grower. Further information about this machine will be awaited with interest. Meanwhile it will be well to remember that, more especially, perhaps, with American inventions, there is often a wide difference between promise and performance.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 1...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., 7¼ p.m. Mr. A. H. Allen, "The Engineering Pros and Cons of the Metric System."

Entomological, 11, Chandos-street, W., 8 p.m.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Drs. C. A. Keane and H. Burrows, "The 'Autolysater,' an Apparatus for the Automatic Estimation of Carbon Dioxide." 2. Mr. O. Guttman, (*a*) "Some Modern Chemical Plant;" (*b*) "Explosions and the Building of Explosive Factories." 3. Mr. H. E. Watt, "The Estimation of Orcinol in Orchella Weed."

Actuaries, Staples-inn-hall, Holborn, W.C., 5 p.m. Annual Meeting.

Tuesday, June 2...Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. Stirling, "Animal Heat and Allied Phenomena." (Lecture II.)

Alpine Club, 23, Savile-row W., 8½ p.m.

Wednesday, June 3...Geological, Burlington-house, W., 8 p.m.

Royal Archæological Institution, 20, Hanover-square, W., 4½ p.m. Dr. Robert Munro, "The Transition between the Palæolithic and Neolithic Civilisations in Europe."

Thursday, June 4...Royal, Burlington-house, W., 4½ p.m.

Antiquaries. Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. A. Dendy, "Note on the Spicules of *Chirodota gemmifera* (Dendy and Hindle)." 2. Mr. E. S. Salmon, "Two new Fungus Diseases." 3. Mr. F. N. Williams, "The Caryophyllaceæ of Tibet." 4. Mr. F. A. Potts, "Polychæta of the Indian Ocean." 5. Dr. S. J. Hickson and Miss Helen M. England, "The Stylasterëa of the Indian Ocean." Messrs. W. N. Cheesman and T. Gibbs, "A Contribution to the Mycology of South Africa."

Chemical, Burlington-house, W., 8½ p.m. 1. Mr. W. Godden, "Condensation Products from Pinene Aminodicarboxylic Acid." 2. Mr. J. S. Jamieson, "A delicate Test for Bromides alone, or in Solution with Chlorides." 3. Messrs. W. H. Perkin and W. J. Pope, "Experiments on the Synthesis of 1-methyloyclohexylidene-4-Acetic Acid." 4. Messrs. M. O. Forster and H. E. Fierz, "The Triazo-group. Part IV. Allyl Azoimide."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. Scott, "The Chemistry of Photography." (Lecture III.)

Friday, June 5...Royal Institution, Albemarle-street, W., 9 p.m. Professor Sir James Dewar, "The Nadir of Temperature and Allied Problems."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, June 6...Royal Institution, Albemarle-street, W. 3 p.m. Dr. H. W. Davies, "The Art of Bach and Future Developments." (Lecture II.)

Journal of the Royal Society of Arts

No. 2,898. VOL. LVI.

FRIDAY, JUNE 5, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

SWINEY PRIZE.

The Council have to give notice that the next award of the Swiney prize will be in January, 1909, the sixty-fifth anniversary of the testator's death. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup, value £100, and money to the same amount; the award is made jointly by the Royal Society of Arts and the College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A.

In accordance with the arrangement with the College of Physicians, the award next year will be for Medical Jurisprudence.

Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter, addressed to the Secretary of the Society.

The following is the list of the recipients :—

1849. J. A. Paris, M.D., and J. Fonblanque, for their work, "Medical Jurisprudence."

1854. Leone Levi, for his work, "The Commercial Law of the World."

1859. Dr. Alfred Swayne Taylor, F.R.S., for his work, "Medical Jurisprudence."

1864. Henry Sumner Maine (afterwards K.C.B.), D.C.L., Member of the Legislative Council of India, for his work, "Ancient Law."

1869. William Augustus Guy, M.D., for his "Principles of Forensic Medicine."

1874. The Right Hon. Sir Robert Joseph Phillimore, D.C.L., for his "Commentaries on International Law."

1879. Dr. Norman Chevers, for his "Manual of Medical Jurisprudence of India."

1884. Sheldon Amos, M.A., for his work, "A Systematic View of the Science of Jurisprudence."

1889. Dr. Charles Meymott Tidy, F.C.S., for his work, "Legal Medicine."

1894. Thomas Erskine Holland, D.C.L., for his work, "The Elements of Jurisprudence."

1899. Dr. J. Dixon Mann, F.R.C.P., for his work, "Forensic Medicine and Toxicology."

1904. Sir Frederick Pollock, Bart., and Professor F. W. Maitland, for their book on "The History of English Law before Edward the First."

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Thursday evening, July 2nd, from 9 to 12 p.m.

The following portions of the Museum will be open :—

The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions; protective resemblance, &c. Also models of the Tsetse-Fly, the Malaria Mosquito, and the life history of the Malaria Parasite. A splendid specimen of the Sea Elephant has recently been placed on exhibition here.

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrated Animals of the British Isles.

The Gallery, containing the Reptiles, in-

cluding the three gigantic fossil forms *Diplodocus* and *Triceratops* from Wyoming, U.S.A., and *Iguanodon* from Bernissart, Belgium.

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

The Reception, by Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert, under the direction of Mr. Harry Tipper, will be given in the Reptilia Gallery from 9.15 till 10.15 p.m., and from 10.30 till 11.30 p.m.

A Gramophone and Auxetophone Concert, under the direction of the Gramophone Company, will be given at the Western End of the Bird Gallery at intervals from 9.15 p.m.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Visitors travelling by District Railway (or other underground railways in connection) will be allowed free use of the Company's Subway.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the day of the conversazione. On that date the price will be 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

A programme of the arrangements for the evening will be published in due course.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, April 30; The RIGHT HON. VISCOUNT MIDLETON in the chair.

The CHAIRMAN said it was not the first time that Lord Lamington had contributed a paper to the Society. In 1892 he read a most interesting paper dealing with his experiences as a traveller in Indo-China. Since then he had been Governor of Queensland and of Bombay, in which high stations he had shown great resourcefulness. His administration had been thoroughly appreciated by the Governments under whom he had served, and also by those over whom he had been called to preside.

The paper read was—

REMINISCENCES OF INDIAN LIFE.

By LORD LAMINGTON, G.C.M.G., G.C.I.E.

I do not presume to call this paper an address, as it contains at best but a series of jottings on various matters connected with Bombay. The paper read by Sir William Lee-Warner in 1904, that more recently by Mr. Lawrence on Agriculture, besides one read by Sir David Barr on the Native States, forbid my dealing deeply on topics disposed of by those of far greater experience than myself.

Whatever may have been the manner of the performance of one's duties, no one who has filled the post of Governor of Bombay could have anything but a natural pride in having had the privilege of being associated with that province, possessed of so many and varied interests, and having for its capital one of the most magnificent cities of the world.

It will ever be a memory to gladden my spirit to recall the view from Malabar Hill. More particularly on one occasion, just before dawn, do I remember the effect produced by the rays of sunlight behind the ghâts, throwing the latter into relief, lighting up the harbour and reddening the roofs and pinnacles of the stately buildings in the Fort, whilst nearer at hand below slumbered Back Bay and its palm-covered shores; and to the North-East streaks of smoke from the tall chimneys showed that the industrial world was awakening, and for once this evidence of human activity really lent a picturesque touch to the scene. At times the disfigurement due to the grimy outpourings of the factories is deplorable. In

private and in public I have discoursed on this theme. Prosecutions did take place, but it was very difficult to secure a conviction against individual offenders. I gather from the latest reports that smoke consumption appliances are being adopted. Let us hope that the use of these, combined with the introduction of electricity produced by water power, and with regulations more stringently enforced in the future, will ensure that one of the most glorious of landscapes will cease to be besmirched by a careless and wasteful expenditure of coal.

Development of Bombay City.

Few subjects had greater interest for me than those connected with the development of Bombay. Situated on a series of islands agglomerated into one, seagirt on three sides and only connected with the mainland by two railways and two narrow causeways, it is cramped like New York, and being the chief gate by which human, commercial, and postal traffic passes in and out of India, the problems of how to assist locomotion and to get rid of overcrowding are not easy to solve.

In 1891 the population was 821,764; in 1901 it had diminished to 776,006, but the latter census was taken after the fourth visitation of plague, which not only thinned its numbers but, through fear, caused many of the floating population to withdraw to their villages in the Mofussil. This was, in fact, a purely temporary check, and the carefully organised municipal census of 1906 showed a total population of 977,822. Presumably you are all well aware of how the Improvement Trust was constituted by Lord Sandhurst's Government with the object of effecting speedy reforms in the city. Its constitution was not popular and its action has often been challenged, on contradictory grounds; sometimes it is charged with going too slow and sometimes with going too fast in the work of demolition and thereby accentuating the evils it has sought to remove. But it can point to the expenditure of 241 lakhs of rupees, or over 1½ million pounds, in pursuit of its object, to the erection of substantial and healthy bungalows in different parts of the Fort, where there is an ever-pressing demand for residential accommodation for both Europeans and Indians. It has reclaimed some 15 acres of foreshore in Colaba adjoining the Fort, at a cost of about 4 lakhs, and this artificially-created land is now leased for building at a rate corresponding to a capital value of about 24 lakhs. Northward of the Fort, near to the southern boundary of the native town, a broad new street, running east and west, has been created, which new artery of communication as well as of ventilation was opened by Her Royal Highness the Princess of Wales, in 1905, and has been appropriately named Princess-street. The land required for this scheme included slum areas purchased at cheap rates, and more valuable plots rising in cost to the very high figure of £66 sterling per square yard. The development of the sites along this truly princely thoroughfare is now proceeding, the plots being leased to private individuals, who have begun the work of construction. About a mile to the northward the trustees have undertaken another and still larger street scheme, extending for a mile and a half, practically from sea to sea, across the island. Elsewhere a compact block of insanitary properties, covering 7½ acres, has been acquired, and, when arrangements for housing the present occupants are completed, demolition and reconstruction will be undertaken. This area is known as Kolivada, where in closely packed and insanitary tenements, abutting on narrow streets and unsavoury lanes, the descendants of one group of the ancient Koli inhabitants of Bombay are collected. This most interesting community has resided here (though not, of course, in the identical dwellings) for many generations. The Christian Koli, whose ancestors were converted under the Portuguese rule, lives peaceably side by side with his Hindu kinsman, each worshipping in his own temple in his own way. The former is, perhaps, singular, in that he frequently possesses simultaneously a Christian name and a Hindu name. The forefathers of these Kolis were among the first loyal subjects of the Company in India and their caste name, Koli, has, I think, given the English language the word "coolie," the Kolis being prominent not only as fishermen, but as palki bearers, soldiers, and unskilled labourers. At Agripada, still further north, in a larger area transferred by Government to the Trust, the work of development is complete as regards roads, sewerage, and water supply, and the leasing of plots for building has begun. At Mahim, in the extreme north of the island, localities now largely composed of fields and cocoanut groves have been marked for development in order to relieve congestion and provide for further expansion. Ten years hence these schemes now in progress will have

done much to transform Bombay. I am quite well aware that my opinion is not the popular one, but except for specific objects I mistrust any official body undertaking building schemes. It may be an impracticable counsel of perfection, but I would like to have seen the central authority solely insisting on the compliance with stringent by-laws in everything concerning health and sanitation, leaving to private companies or individuals the development of land for buildings. Of course, only a central body could condemn insanitary areas and broaden streets, but in the long run I believe that the rehousing of displaced people would be met better and more speedily by private enterprise. So long as a public body provides houses for private individuals, an uncertainty in the building trade is created, which frightens capital from such investments. This has been demonstrated in Edinburgh, Leith, and Glasgow, where it has been conclusively shown that corporation tenements have done nothing for the poor and are worse let than the average. In London and Bombay it has been shown that buildings for dishoused people are rarely occupied by those particular people for whom they have been constructed. Possibly historical students may know, though others do not, that a century ago, in 1803, the then Government of Bombay seized the opportunity afforded by a great fire in the northern part of the then existing native town to appoint a committee to carry out somewhat similar schemes of improvement. So there is nothing new under the sun. Luckily we need no longer, as then, subordinate our schemes to considerations of external defence. The Board of Trustees, when paying £9 per square foot for small plots of land, have reason to know that in popular estimation property is secure, and, presumably, do not agree with Pepys, in the seventeenth century, that—

> "The Portuguese have choused us in the island of Bombay which is in the East Indies. . . . . It being, if we had it, a poor place. . . . . Whereas they made the King and Lord Chancellor and other learned men about the King believe that that and other islands which are near it were all of one piece, but it is quite otherwise."

Possibly, when searching for new building plots to relieve congestion, the Trustees recall with envy the conditions existing when in 1668 the local authorities considered that "hogs and ducks cannot be hastily encouraged as they are looked upon as the annoyance of this island in the time of corn," or when in 1684 the Court of Directors wanted "that woodland upon Malabar Point let for growing pepper."

There is one scheme that I had much at heart, which was to reclaim a broad and long belt on the eastern shore of Back Bay. The northern portion of this, some 160 acres, I would reserve as a maidan and recreation ground, so sorely needed. The southern and broader end would be devoted to building, and, according to the figures compiled by a special committee appointed by Government, the income thus derived would repay the cost of the scheme. It would be flanked by a fine drive and ride along the sea-front. That done I think there should be no further encroachment on Back Bay. It is most undesirable to check the prevailing breezes that sweep in over its surface, bringing freshness to invigorate the toilers in the Fort, and, besides, any breach of its noble sweep would greviously impair the beauty of the city.

Bombay rejoices in a great supply of stored water, though extra pipes will be required to meet the growing demand, and to make good the leakage that takes place in the city reservoirs. The finances are in excellent condition, and year by year it has been possible to reduce taxation.

Factory Labour.

Before leaving the subject of Bombay city may I be allowed briefly to refer to the question of factory labour? A committee, under the chairmanship of Sir H. Freer-Smith, was appointed, and reported, and now a Commission is more thoroughly investigating the matter. I rather doubt whether an interference with the hours of adult male labour will be practicable. If the maximum were fixed it would have to be at a very high number, for the Indian does not work assiduously and continuously like the European; now and again he leaves his work to smoke a pipe and chat. It is generally agreed that women are sufficiently protected already. Where reform is most required is in raising the age and reducing the hours of child labour. More frequent and efficient inspection would, even on the present footing, help to rectify much of the attendant evil, though, so far as I can gather from the reports of evidence and from statements made, the Bombay system of inspection compares more than favourably with that elsewhere.

It must be remembered that the imposition of any drastic regulations will be re-

garded with suspicion, as being imposed in the interests of our home manufacturers, though in this case it was the *Times of India* that first drew public attention in a powerful series of articles to abuses that were prevalent. It is a fact that may not be widely known that the workers themselves have now learnt to combine, and many instances have occurred of strikers being successful in obtaining a reduction of hours, the raising of pay, or other such concessions. India, moreover, is a big country to legislate for as a whole, and local conditions vary; thus in Bombay factories are largely owned and managed by Indians; in the rest of India, Europeans usually take their place. The quality and thoroughness of labour also differs; in the Mofussil it is of far less value, and I remember the manager of a mill run by water power telling me that it would have been more economical, despite this saving, to have had the mill in Bombay, where labour was more skilled and effective. Closely bearing on this question is the noticeable fact of the great scarcity of labour. This is due to plague, famine, and emigration, as well as to the increase of manufacturing and the development of mining enterprise. Wherever I went I heard complaints of the lack of labour. Lands in remote or unhealthy tracts are lying waste, factories cannot be run, and recently I read that the new harbour scheme at Karachi would be retarded by the difficulty of getting workmen. A further proof of the demand for labour is found in the continual rise in the wages of every class of subordinate service. Shortly before leaving Bombay I was told that a skilled working coolie on the railway could earn a rupee (1s. 4d.) a day. This may not sound much to a British audience, but it is a fortune compared with the daily wage of 2 or 3 annas prevalent 30 years ago.

Other prices, it is true, have risen also, breadstuffs and the like, but on the whole, it cannot be denied that the labourer of to-day has a far greater command of money now than in the past, with a corresponding increase in the standard of comfort in living, a fact borne out by Mr. J. D. Rees, M.P., in his recently published volume entitled "Real India."

Primary Education.

What is needed now is to diffuse primary and technical education by which the people can take advantage of this new order of things. Primary education in my successor's fine address at the recent meeting of Convocation is termed the weakness in the foundation of the educational fabric. Still in most places there is a growing appreciation of education, and I am rather doubtful whether it is necessary or advisable to encourage education further by making it free as it is proposed to do at the expense of the whole body of taxpayers. However this is not the time or place to discuss the matter, though I may mention that before the Government ventilated the subject it had been repeatedly brought forward by a Mohammedan, Mr. Ibrahim Rahimtoola, who has long been a member of the Legislative Council of the Governor of Bombay.

The Government of India have given in recent years large special grants for the furtherance of primary education. But not one village in three has a school, so there is a large field to overtake. We are so accustomed to thoroughness in every detail that in India real progress is often hampered by the fear of initial expenditure, which less ambitious ideas would reduce to a minimum. Thus, in regard to primary education, would it not be better to make the funds go farther by having schoolhouses less of a model and expensive type, and so diffuse more widely educational advantages by spreading the money over a larger area? Let the teaching be sound, but buildings more in keeping with the people's normal manner of life would be sufficient. Primary education is an essential not only to fit the people to participate in the development of industries such as spinning and weaving, but also to enable them to understand more clearly the benefits that accrue from the various scientific and administrative reforms that we seek to introduce, such as inoculation against plague, village sanitation, agricultural improvements, co-operative banks, and a host of such objects, which up till now have been so foreign to the habits of the people that their advocacy is always liable to engender suspicion and make our rule unpopular.

Primary education should have a specially useful function in maintaining the independent status of that sturdy person, "the poor ryot," as against those who might make use of him for political purposes, and against any fraudulent attempts of the sowkar to deprive him of his land. In former days, when the money-lender became oppressive, he suffered in his person or in his property, possibly was dropped out of sight down a well. We disapprove of such ready-made justice, and the ignorant

ryot has fought the sowkar on unequal terms when the latter could invoke the aid of the law and point to written bonds as evidence of the mortgage.

Various Acts have been passed to safeguard the ryot, but education is his best weapon of protection. So primary education enables the downtrodden to assert his manhood, the simple to hold his own against the cunning, the poor to be no longer the serfs of the rich, gives the opportunity to one and all to enter on fresh paths of industry, and to understand better the aims of our administration, however little they may like it for its own sake.

In a recently published volume, styled "Indian Jottings," written by a missionary at Poona, some interesting sidelights are thrown on Indian character. The author testifies to his work being chiefly conducted by means of education, and states how particular parents are that the teachers should be competent. Missionary schools are a striking feature throughout the Bombay Presidency, and my admiration was often won for the self-sacrificing and laborious lives that are led by the members of the many and varied missionary bodies. In the majority of cases they make a special effort to teach handicrafts, and give very efficient manual instruction. It is worthy of remark that, though Indians may at times resent proselytising, they never, so far as my experience goes, object to the adherents of a creed following their own religious observances when conducted without offence to other people, nor do they find fault with Government supplying land or money for such purposes.

Technical schools are established in the larger towns. In some cases I fear that the instruction has not practical value in equipping a boy with skill that he can turn to account. Some schools could be usefully closed, and efforts concentrated in those places where a *clientèle* can be obtained who will put their knowledge to real account. The Victoria Jubilee Technical Institute in Bombay, the College of Science at Poona, and other such institutions, attract students from far and wide.

Mention of private other than missionary schools must not be omitted, some of which reach a high standard of efficiency. One of these, in Bombay city, under the control of Mr. Murzban and his partner, is the largest in the Indian Empire, possibly in the British Empire, and is maintained entirely out of fees collected from the pupils, who number 1,700 or 1,800. The school is most successful in passing boys for matriculation, as well as training them in athletics and cricket, and is termed by Mr. Selby, Director of Public Instruction in his report of last year, "a model institution."

In higher education, the Fergusson College is another example of self-help. It only receives a grant-in-aid of about Rs.8,000, but it has attained a high position amongst other such institutions, and reflects credit on the Deccan Education Society, on the professors, who on small salaries devote themselves to their duties. Mr. Gokhale in the past, and now Mr. Paranjpe, are associated with the headship of the college.

Higher Education.

I need say but a few words on higher education, and how Lord Curzon incurred odium in his determination to introduce a loftier tone of discipline and character by means of the Universities' Act. No doubt the acquisition of Western learning, cheaply obtained, and so suddenly that a concurrent development of character was precluded, has been the main cause of discontented feeling, when scholars, their studies over, found an insufficiency of Government employment to satisfy their numbers, and had not acquired the aptitude to turn their knowledge to their practical benefit or profit. In some degree, to remedy this, a greater sense of responsibility might be engrafted by raising the fees and price of education to a figure more nearly approximating to its cost, and thus inculcating the truth that what is worth having must be obtained by struggle and sacrifice. The standard of scholarship and thoroughness would rise, and the love of knowledge for its own sake increase. Education would cease to mean only the acquisition of certificates of fitness for Government employment, and young men would seek it in order to qualify and equip themselves for some definite calling in life. Such value is attached to the possession of any connection with university tests, that for the purposes of advertising it is quite common to see "Failed" prefixed to the desired but lost distinction.

Co-operative Land Banks.

I should like to refer to the subject of co-operative land banks, by which it is hoped to help the ryot to escape the clutches of the sowkar, and to introduce generally a spirit of self-help and mutual understanding amongst the peasantry.

The Act of 1904 provided for the registration of co-operative societies formed on certain specific lines, allowing each society to adopt its own bye-laws. The Government of India placed small grants at the disposal of local governments for distribution as loans to the societies, prescribing strict conditions as to the allocation of the money. Though for some years, prior to 1904, the possibilities of co-operative credit had been discussed, to the great majority of even the educated classes in the Presidency, the subject was an obscure one. The possibility of a credit agency alternative to that of the individual moneylender, had not entered the popular mind. Fear of incurring the sowkar's hostility, mutual distrust, and anxiety as to the method of recovering debts due to a society were found to be the chief obstacles to the development of the system.

Village societies were organised on the basis of unlimited liability as urged by Raffeisen, and this principle, though criticised by the Press, has proved to be no stumbling-block. The business of a rural society is conducted by a committee of seven, holding office for a year, and eligible for re-election. It has been found that if business is managed on easily understood lines of routine, a committee gifted with a moderate amount of courage, disinterestedness, and foresight, will achieve a creditable amount of success. Undue favouritism and laxity are repressed by the consciousness that each member has pledged his unlimited liability.

So far, serious trouble has not been occasioned by default, but it is regarded as a defect that a debt can only be recovered through the civil court. In all parts of the Presidency, villagers have stated that but for this they would immediately form a society. They urge that they may try to give loans to reliable borrowers only, but that if the agency is to be generally useful it must meet the wants of the average villager, who is not naturally dishonest, but is often careless or improvident; nothing they say will make him alive to his resposibilities so much as a conviction that neglect of duty will meet with certain and reasonably prompt correction. The Bombay Government hoped to devise a system of summary adjudication and recovery, but the Government of India vetoed the proposal. Were this amendment made, capital would be more readily supplied, and this is a great need.

The members of committee receive no remuneration, and the last annual report shows that whilst 4 lakhs of rupees were received and disbursed by all the societies the outlay on establishments and stationery was only Rs. 1,500, or about 3-8ths per cent.

The first society was formed in the village of Kanginhal in the Gadag taluka of the Dharwar district in May, 1905, and when two years old its members numbered 186. In June, 1907, there were 49 rural societies with a membership of over 3,200, and 20 urban societies with more than 1,660 members. One of the latter, the Bombay Urban Society, was formed largely at the initiation of the Hon. Mr. Vithaldas Thackersey to supply capital to small rural societies, and it has been a conspicuous example of success.

It will thus be seen that a very creditable effort has been made by the people generally (as the existing societies are distributed over the three divisions of the Presidency and the Province of Sind) to take advantage of a system which has almost unlimited possibilities for good.

From the outset it was the policy of the Bombay Government that its officers should aim at quality rather than quantity in the work of organisation in order that failures might not occasion distrust of co-operative methods. That it should have been possible to inaugurate a totally new system with such chances of success, shows the cordial relations that can exist between officials and those under their charge. Incidentally, I may mention that I believe the confidence that has been generally established is largely due to the practice of seven months' touring in tents that district officers in Bombay, have to make, bringing them into close contact with the people.

Police.

Time forbids my saying much about the police and the efforts that are being made to improve the service by raising the pay and by other needed reforms. The commission that was appointed by Lord Curzon clearly showed that the force needed reforming, and were often oppressive to the people living in the Mofussil, a state of things due to the men being recruited from low grades of society, and being underpaid. It is no easy matter to disentangle the truth from the meshes of the charges and counter-charges that enwrap cases brought before a magistrate. Dacoity is still by no means infrequent, and, with few exceptions, people have not overcome their old-time habits, and in places

the feeling of security to induce them to live in isolated homesteads is wanting. This leads to two great evils—first, a serious absence of sanitation in the crowded villages and consequent liability to epidemic diseases, such as plague and cholera; second, a great loss of valuable agricultural manure. Large numbers of cattle are stalled in the villages, but the arrangements for the preservation of farmyard manure are of the most wasteful description, and its ordinary ultimate use is for fuel.

Sind.

I would now, for a few minutes, turn your attention to Sind, where gigantic strides have been made in irrigation and in agriculture, particularly in regard to cotton cultivation. Perennial irrigation in this province may afford the one opportunity in India of growing successfully Egyptian cotton, worth at least twice as much as the indigenous variety.

There is one great project taken in hand which I had hoped to inaugurate before leaving, viz., the construction of a weir on the Indus between Sukkur and Rohri. This is the only point during the course of the river through Sind, where a belt of limestone rocks protrudes, offering a foundation for the construction of a barrage. Borings of the rock were still being made when I left. The height of the river will be raised only a very few feet, but this will enable a large canal on either bank of the river to be fed perennially. These two canals will feed the whole system of minor canals, excepting those in the Karachi district below Kotri, and thus save the numerous mouths, as at present existing, of the many different canals, which, by reason of alterations of the river's course, and accumulations of detritus, require a large annual expenditure for their clearance. Surveys were still being made to show whether new areas could be commanded. This undertaking, which will be one of the most important works of its kind in the world, is the more necessary as it is feared that the great development of irrigation in the Punjab is reducing the inundation of the Indus to so low a level as to injure the irrigation prospects of Sind.

Unluckily the Sindi is a very lazy cultivator, he over-waters his land, and will not take the trouble that Egyptian cotton requires in cultivation. Punjabis and others are coming in considerable numbers to certain districts, and are introducing more careful methods.

The rail and river-borne trade of Sind, in 1906-7, increased by 13 per cent. in quantity over the previous year, and 22 per cent. in value, totalling 591 lakhs of maunds in quantity, and over 31 crores in value.

The development of agriculture in Sind and the Punjab has caused the trade of Karachi to advance by leaps and bounds, and the port has had great difficulty in coping with the work. In the last ten years the imports by rail into Karachi have increased from 11 million maunds in 1897, to 38 millions in 1907. Exports in the same period have increased from 4 millions to 17 millions sterling. The figures for last year show that the total volume of trade exceeded that of 1904, the previous best year, by 23 per cent., or about £4,500,000, in value, the exports of wheat amounting to a million tons. The Karachi Port Trust have prospered under these circumstances, and there is a large scheme put forward to improve the accommodation of the Port to meet the growing demands made on it. In 1905-6, the income and expenditure were respectively, 24 lakhs and 10 lakhs; for 1906-7, these figures were raised to 29 lakhs and 20 lakhs respectively. There is a reserve fund of 20 lakhs, as against 5 lakhs in 1905.

These figures give some idea of the prodigious growth of Karachi as the north-western port of India. The aspirations of its inhabitants follow suit, and expectations of its being a rival to Bombay in trade and manufactures at times find utterance. It may, however, be questioned whether the place is suitable for the spinning of cotton, though a fairly good climate to live in, and in the cold season distinctly invigorating. Its situation, so entirely dissimilar from Bombay in its lack of striking features, has its attraction in the aspect of a thriving town rearing itself from the surrounding sand waste: and in the long entrance from Manora to the harbour itself, one is proud of what human skill and energy has been able to create. Sind has its peculiar interest to officers stationed there, despite the excessive heat in the hot weather, when 123° in the shade is often registered at Jacobabad. It is the Egypt of India, with the Indus, the counterpart of the Nile, irrigating and fertilizing the country on either bank. Excepting Burma, it is about the most recent of our conquests, having come under our sway only sixty-five years ago. The people are perhaps more virile than in the Bombay Presidency proper, and there is more turbulence. The problem of finding capable, well-educated Mohammedans to fill administrative offices in a distinctively

Mohammedan country is ever present. One of the great obstacles, in addition to their general indifference, is the amount of time, some $2\frac{1}{2}$ hours daily, spent in schools (not having a Government curriculum) in prayers and religious exercises. They will not send their children freely to Government schools, but to their own State-aided schools.

Now I will take the briefest survey of some of the more salient features of the various places I visited. The ancient town of Thatta, is a place in the delta, where tiles and pottery were made of beautiful colourings which cannot be now produced. But the interiors of the mosques are still gorgeous with the blue encaustic tile-work most refreshing to the eye after the outside glare and heat. Umarkot, the chief town of Thar and Parkar, is the birthplace of Akbar, the son of Humayun when the latter was an exile from his kingdom of Hindustan. Through here did Akbar march in 1591 when on his way to conquer Sind. To the west and north are trees and irrigated and fertile lands, to the south and east one gazes from the old fort walls over the desert, the sands of which touch the foot of the walls and stretch far away in great dunes and billows. The numerous beds of long dried-up rivers from here eastward would seem to indicate that at one time some branches of the Indus flowed over this district.

Hyderabad, the junction of the Rajputana-Malwa, and North-West system of railways, is the capital of the district of that name. The fort, situated at the southern end of a low range of hills on which the town is built, dominates the railway station and was three years ago the scene of a disastrous cordite explosion. The municipality are not always very tractable, and feuds between Mohammedans and Amils, the Hindu *literati* of Sind, are apt to arise. Our conquest of Sind was effected when Sir C. Napier was attacked at the Residency on the Indus about three miles away, and two days later won the decisive battle of Meeanee, nine miles off, followed a week later by the complete defeat of Sher Muhammed at Dabo.

Several of the Mirs, the descendants of the former rulers of Sind, live near Hyderabad, and one, the son of a Mir who fought against Sir C. Napier and who well remembered him, came to pay his respects. The town has a curious appearance owing to the ventilators, looking like windsails, that are fixed on the roof of every house so as to catch the south-west breeze.

Sukkur and Rohri, that face one another across the Indus, are picturesque by reason of the white gauntness of their aspect, relieved by groves of palms and babuls on the banks of the river, the island fortress of Bukkur that lies between them, and the great railway and road-bridge overhead. At Rohri, in the shrine of Wah Maburak is preserved very jealously a hair of Mohamed's beard. Then there is Larkhana, embowered in trees; Shikarpur, whose traders go far afield into Turkestan and Central Asia, and whose women are renowned for their good looks. My arrival was marked by gold and silver films being thrown for the populace to scramble for, and when driving or walking through the narrow picturesque bazaar man, woman and child joined in showering on one fragrant rose leaves. The population here are unusually light-hearted, they have pretty gardens outside the town, and there they have parties, as well as on the river, where they amuse themselves by swimming, and floating on gourds. Jacobabad was founded and developed by the ceaseless activity of General John Jacob. A reminiscence of him yet exists in the form of a clock of his own manufacture that still works in the hall of the Presidency. Under the ægis of the Government, horse breeding is successfully carried on in this district; the show that was held was well worth seeing. But the feature of the place was the throng of wild looking Baluchis that thronged the bazaars. There must have been at least 10,000 gathered on the course when the horse and camel races took place. I fear that the town has fallen on evil days now that the cavalry regiment is to be stationed at Quetta.

I cannot omit reference to Khairpur, the one native State in Sind. Roads in these parts are "metalled" with long grass or reeds, which makes driving very luxurious. The ruler is an old and loyal man, a great sportsman, and maintains a camel corps as his contribution to the Imperial Service troops.

Bombay Presidency.

I took a tour in Cutch to examine the alternative route for the broad-gauge connection to link up the railways of Sind with those of the Presidency. I have not the time, nor the the power to describe intense interest, human and otherwise, that attends such a journey. I would like to dilate on the picturesque landing at Mandiv, the port for Bhuj, the capital, 40 miles inland, the drive through the tortuous streets, the curious carved Dutch figures on

the façade of Rao Lakhput's house, the fertile coast country in the interior becoming sterile and waterless, the procession of the yellow-coated mounted bodyguard, and mounted police, the elephants, gorgeous in their trappings, the silver-horned bullocks, the retainers with every species of antique weapon, armour and insignia, the great Durbar hall, the drive to the Palace along the narrow street between high walls lined with enthusiastic crowds, the Hall of Mirrors in the Palace and another room with the floor in the centre surrounded by water excepting for a narrow bridge; here when relatives or subordinate chiefs met, jets of water could be turned on did controversionalists get excited. I may mention that a form of greeting dying out elsewhere, is still common here, this consists in the women with their elbows stuck out cracking their knuckles on the sides of their forehead, in token that they take your woes and sins on themselves. I rode through the rugged and barren westernmost half of this isolated state to Lakhpat on the Little Rann, where the waters in the Straits for miles looked exactly like blood, so crimson and thick were they with some form of small red jelly-fish.

I afterwards inspected the northern alternative route for the railway, passing through the very rich district of the Palanpur Agency, which, however, in unprecedented fashion, had suffered much in recent years from droughts. There had been lately a sudden flood in the Banas river which spread over the country in sheets of water many miles broad. The country, the whole way to Singam, is very flat; bird and game life appeared more abundant than I had seen anywhere else in the Presidency, which may be regarded as evidence of a fertile land. The Rann had the appearance of a vast ploughed field that has been slightly flooded, then half frozen and finally sprinkled with snow. Nagar Parkar is a small town situated on a kind of peninsula formed by a hill of granite, the only supply of rock or stone that exists for a great distance around. Our further ride took us across another arm of the Rann to Aniali, in Thar and Parkar, where we encountered the sand dunes that roll from here to Umarkot, which I have already mentioned. In the declivities or synclines between the dunes there is a scanty herbage, and here the small flocks of the poorest people that I ever saw obtain a subsistence very precarious except when the rains are plentiful. The misery and destitution of the people was extreme, and if only to bring them more into contact with civilisation, from which they are now so entirely cut off, the railway would be a blessing. The one obstacle is the absence of fresh water, which would have to be brought great distances.

It would be a theme for more than one paper to touch on the unique congeries of Native States in Kathiawar. The people, the variety of States, their history, romance, politics, and originality all combine to give Kathiawar a very special fascination. Junagadh alone, with its quaint old town, the Asoka stone, the sacred hill of the Girnar and the Gir Forest, where alone the Indian lion is still to be found, deserves a paper to itself. We have here now in this country the Jam of Jamnagar, or, as he is more popularly known, Ranji, the cricketer, and his capital of Nawanagar has many quaint buildings and is pleasantly situated. When visiting these States, or when a Durbar is held at Rajkot, the headquarters station of the Agent to the Governor, scenes such as I have outlined in my reference to Cutch repeat themselves, each State having its own particular form of display. The chiefs in Kathiawar are renowned for their go-ahead method, yet staunchly maintain, and rightly, their individual State traditions and characteristics. They are keen in developing their ports and trade, conjointly they work the railways in Kathiawar, they maintain the Chiefs' College at Rajkot, and in many ways exhibit enterprise.

The Province of Gujarat, sometimes called the garden of Western India, is full of varied interest. In the North a series of Native States are grouped along the valleys of the Mahi and the Rewa. At Ahmedabad, palace, mosque, and mausoleum, all carved with delicate tracery, unsurpassed by any detail in Greek or Gothic architecture, bear silent witness to its former magnificence when it was the capital of Mogul Viceroys before the Gulf of Cambay was silted up. The Commissioner's house, known as the Shahi Bagh, in which we stayed, was built by Shah Jehan when Viceroy of Ahmedabad, to give work to the poor in time of scarcity. It stands a massive structure overlooking the river Sabarmati, which is reached through a terraced garden, famous in the seventeenth century for its beauty. Broach gives its name to the longest stapled cotton in India: at Surat, the first foothold and home of the British race in India, still stands the house which was in all probability our original factory. This town is now the headquarters of

the pearl trade of the Persian Gulf and Kathiawar, and if you make acquaintance with its merchant princes you may see these precious articles of adornment stowed away in sacks like so much corn. Here, too, are tombs of British and Dutch officials and traders of the seventeenth century, vying with one another in splendid pomposity.

From Surat you pass into the Bhil country, first the Dàng forests, where the inhabitants eke out a subsistence by collecting and selling the Mohwra flower, used for the distillation of spirit, and then the wild jungly hills of Khandesh are reached, where the name of Outram is still held in reverence. Khandesh to the Deccan is an easy step. Here we find Ahmednagar, where Aurangzeb died, and then we arrive at the home of the Mahrattas, historic Poona with many towns around that have figured in history, and numerous great forts that crown the hills, themselves crested with fortlike scarps. The Deccan formation is composed of vast sheets of trap rock, some thousands of feet in thickness, and the hills are those portions of the plateau that have resisted denudation. The western crest impinges on the coast so that the watershed not far south of Bombay is but 30 or 40 miles from the sea, whereas the eastern shore of India is some 700 miles distant. In Queensland, where I had been previously as Governor, the position was reversed. The watershed was from 50 to 80 miles from the Pacific, and over 1,000 miles from the nearest shores of the great Australian Bight.

Bijapur, once the capital of the Nizam Shahi dynasty, whose kingdom was carved out of the ruins of the Bahmani Empire, is full of ancient remains, which are less visited than they deserve. It is the centre of a tract that would often be decimated by famine had not the railways robbed famine of its worst sting. Leaving the plateau and descending the great staircase of the Ghauts the Konkan is reached, with its beautiful coast-line and its forts, the homes of the Angria pirates, of African descent. Many sea fights we had along these shores, many are the places marked by the graves of our fellow-countrymen, for instance, on the island of Anjidiv, where a British force was detained by the refusal of the Portuguese commander to cede the island of Bombay, and in two years was reduced by sickness from 500 to 119 men. Honawar, famous for its gallant defence by Captain Torriano in 1783; Bhatkal, where in 1760 the whole of the English factors were slain because a bulldog that one of them owned killed a cow. Kanara, the southernmost district of Bombay, has its magnificent forests, amongst which are situated the Gersoppa Falls, 800 feet high, affording probably the most beautiful scene in India. Here the mode of locomotion is to be carried in munchils or litters by relays of porters, who shuffle along at a half run, awakening the recesses of the forest by chanting weird monotonous refrains, whilst at night a crowd of other carriers illuminate the passage through the dense jungle with long and blazing bamboo torches.

Nothing can be more charming than Karwar with its silvery beach and palms and *Casuarinas* growing to the water's edge, or Savantvadi, embowered amongst trees. Except for the mango tope, or grove, occasional bits of jungle, or the blue *Lagerströmia* by the streams, vegetation in its big effects is, I think, disappointing in the Presidency, until the great and luxuriant forests of Kanara are reached. The State of Kolhapur, situated on the Ghâts, is the most important of all the many States that come under the administration of Bombay, and has especial interest as its ruler is descended by adoption from Sivaji.

The Bombay Presidency presents no less variety of race and caste than it does of physical features. There are the acute-minded Brahmans, the Mahrattas of fighting instinct, the seafaring Lascar, the skilled Gugerati ryot, the trader of Cutch, the Parsi of business and administrative aptitude. How striking the contrast between the industrious, highly-educated Indian in Bombay city, and the wild aboriginal Kathkaris, living in the jungle a few miles outside.

Till the middle of the last century, the confines of Bombay's control and supervision included Baghdad, Cairo, Somaliland, and Zanzibar. Aden is still under its charge. Last year, I had the pleasure of inspecting some of Bombay's outlying possessions. Perim, composed literally of basalt and sand, is often abused, but even Perim has its defenders, who boast of its healthiness, its excellent sea fishing, and its glorious sunsets. Aden, the administration of which occupied a good deal of time, always particularly interested me. I should like to have seen solved the questions of the deepening of the harbour, to have considered further the introduction of a water supply from the interior in lieu of the

present system of condensers, the possibilities of a railway, our relations with the inland tribes, and many such matters. The situation and aspect of this gaunt fortress and *entrepôt* of trade has always appealed to me. The Gibraltar of the Arabian seas, with the full tide of civilisation streaming past, a few miles off, on the far side of the neck of the peninsula, democratic tribes are living in primitive wildness. I wish there had been time to have narrated something of my visit to Lahej, a large and very fertile oasis in the desert, where troops of warriors, mounted on camels, performed a Mahaf, or military tournament. I would have said something of Shugra, also of Mokalla, the capital of Shehr and Mokalla, whose Sultan is the most important chief on the coast. The town, a city of white-topped houses, lies squeezed between the shore and beetling cliffs, whose great crags look as if they might at any moment crash down and destroy it.

I paid a visit to the little-known Socotra with its curious vegetation of dragon's blood and other trees, some producing aromatic gums, such as the frankincense for which the island in the Middle Ages was renowned and much resorted to. The people are well-built, with curling hair. They are neither Arab nor Somali, though at Tamdrida, the little town on the coast, the population is mixed with African and Arab blood. Near here are the remains of a camp where in 1835 a British force was decimated by fever. The camels are remarkable for their climbing capabilities, and carried us more securely over rocky paths into a mountain gorge than when travelling on the flat. The scenery of the island is fine, granite peaks rise to 4,000 feet, but what was chiefly pleasing was the unaccustomed sight of clear mountain streams. The valleys are fertile, but are not cultivated, the inhabitants subsisting on dates and on their large flocks of sheep and goats.

These reminiscences have been but jotted down, and I fear must have wearied you. I can but regret it, for I should feel proud if I could only give you a minute part of the joy that these memories afford me. In the absorbing interest of its work and duties, in its never tiring scenes of Indian life, in its picturesque charm, in its sunshine, in its historical associations and also in the friendships that it allows to be formed with the inhabitants of the country, as well as with his fellow-workers, the life of a Governor of Bombay is indeed almost ideal.

DISCUSSION.

The CHAIRMAN (Lord Midleton) said that before he accepted the invitation to preside over the meeting, he had also agreed to preside at a meeting to be held later in the evening at Guildford, and as it would be necessary for him to leave very shortly, he would be only able to make a few remarks. He desired to express his appreciation of the admirable paper which Lord Lamington had read, and wished particularly to emphasise two points. The first was that it fell to the people of this country to see only the results of the labours which were carried on by those who worked in India. Strings of figures were given showing that India was the most prosperous country, in regard to its debt, of any country in the world, because the whole of its debt was represented by assets in the railways and irrigation works; but nothing was heard of the labour by which, in isolated places, and very often with great privations, those results had been achieved. The second point on which he would like to have enlarged was that he did not think anybody could have heard what the author had said, not only as to the administrative problems of Bombay, but also of other parts of the country, many of them remote, and necessarily to a large extent unvisited, which came under the sway of the Governor of Bombay, without feeling how impossible it would be to concentrate the whole administration of India in Calcutta—how desirable it was that both in Bombay and Madras there should be Governors who had a large degree of independence in all matters which were not of first-rate and Imperial concern. He would like to have said more on those two points, but he had a duty to perform to another audience, and he would, therefore, ask Sir William Lee-Warner to occupy the chair, and to continue the discussion.

Sir WILLIAM LEE-WARNER, in taking the chair, desired to express the general regret that Lord Midleton had been forced to leave the chair by a public engagement elsewhere without completing his speech, the more so as he had left no notes for the guidance of his successor. Thus unexpectedly summoned to that position, he hoped that allowance would be kindly made for the unprecedented predicament in which he stood. Lord Lamington must have warmed all hearts by his rapid and interesting survey of scenes, as of men, in Bombay. He had touched on the variety of Bombay scenery, a veritable epitome of the world's stores of nature, the deserts in Sind, with the sand dunes so graphically described, the rich luxuriance of Canara and the Konkan, with their gurgling streams and perpetual richness of verdure; the rolling Deccan plains, and the fertile gardens of Guzerat, with its splendid trees; the deep forests on the Ghauts, inhabited by aboriginal races, at constant warfare with wild beast and fever; and then the rich black soil and alluvial deposits of the Southern Maratta country, bearing their plentiful crops of grain

and cotton. The same variety was to be observed in the races of men. On the slides we had seen the wild, long-haired Baluchis, the hard-faced Afghans, the patient, wiry, Maratta peasantry, and the whole world's population thronging the streets of Bombay. That was a city of which its inhabitants might be proud. Without claiming for the Presidency the first, or even the second place in the great provinces of India, a claim which, looking at his audience, he would not now advance, all present would agree that no city was better fitted, by grace of scenery, architectural beauty, and other amenities, to be the gate of India, the place of arrival for Indian visitors. No wonder that Lord Lamington had left his heart there, as others had done before. Then, again, the variety of administrative problems was a great charm of the Governor's office. Sind had been referred to, and Lord Lamington had mentioned how the realisation of Lord Dalhousie's dreams, and the conversion of Southern Punjab from desert to cultivation by means of irrigation, had reduced the waters of the Indus available for the same work in Sind. This recalled the experience of the Delta of Egypt, that its salvation depended upon the control of the waters in the Upper Nile. That was not the only similarity between Egypt and Sind. The barrage of Sukkur recalled that of Assouan, and generally the whole Government of Sind was not a whit less interesting than that of Egypt, which had so lately been brought before the public by Lord Cromer's splendid account of his work there. The Chairman would not weary the audience by tracing the numerous and quite different problems that arose with the indebted peasantry of the Deccan, and the richer landowner in Guzerat. He was glad to observe that Lord Lamington was struck by the Bombay system of keeping the collectors and their assistants out on tour for seven months in the year. It was the best way of learning the needs of the people and bridging the gulf between ruler and ruled. Every Governor of Bombay had felt its value. Lord Midleton had briefly referred to the importance of preserving the independence of the local Governors of Madras and Bombay. No doubt the control of the Government of India and of the Secretary of State must be maintained, but it was of vital consequence to the progress of India that the hands of the local Government should not be tied by minute interference, and vain attempts to prescribe one system of administration in all its details for different provinces of India which essentially differed from each other. The Government of Bombay was entrusted to a Governor and two Members of Council; it was Government by a Board and not a Dictator. He did not wish to say that the same form of government was good for every province. Government by a Lieutenant-Governor secured a life's preparation for the task, prompt executive action, a thorough knowledge of the capacities of the men in the service, and it held out a noble and proper reward for good work to a whole service. On the other hand, the Presidential system brought to the work a fresh mind perhaps better acquainted with the trend of public opinion at home, far greater deliberation in the settlement of questions, more uniform, if perhaps slower, progress, and a guarantee of impartiality in the distribution of patronage. Taking only the Governors with whom he had served at headquarters, he recalled the very high tone of official duty which Sir Philip Wodehouse brought to the task of governing, Sir Richard Temple's masterly activity, Lord Reay's experience of, and his new ideals of education, and Lord Harris's stimulating personal interest in the work and lives of all his subordinates, and his practical good sense. Each Governor of Bombay had brought something new to the common heap, and he was quite sure that public opinion in Bombay, whether of Europeans or Indians, would strongly resent any conversion of the Government from the Presidential system to the dictatorship of a single Lieutenant-Governor, although the Governor might, as he had been in the past, be chosen from the Indian services. A good instance of the importance of not reducing all India to one level, nor assuming that what might suit Bengal must suit Bombay, was afforded by the question of free primary education which had lately been discussed in the House of Commons. All of a sudden, and without consulting the local Government, the Government of India had launched the idea of abolishing fees in primary schools. To one who did not come to close quarters with the difficulties, the idea seemed excellent and simple. Free primary education was recognised as sound in the United Kingdom, everybody in India was agreed in wishing to extend primary education, and the obvious remedy seemed to be the abolition of fees. But any Bombay official could tell you off-hand that the country was not ripe for such a sacrifice of funds now devoted to the extension of primary education. Government might easily bear the loss in its few Government schools, but municipalities and local fund committees would stagger under it. Native States could not follow suit, the managers of aided schools would have to close half their classes, and the unaided schools would die out. The fees now paid for primary education were a most important asset in the ways and means for supplying and extending primary education. The State could not even make good the loss, much less increase its grants, without fresh taxation. Other claims upon public revenues must be borne in mind, especially sanitation. In short, the idea which struck some one at Simla as the most natural easy project would never have gone so near to being publicly proclaimed as an intention of Government, if local knowledge had been added to a generous instinct. As Lord Midleton had indicated, it was all important to avoid over-centralisation, and the Chairman thought that education was one of the departments which ought to be wholly left to the local Government without any central department,

or more than a general guiding hand from the Government of India. Bombay had long taken a high place in education, being the first in the field with its Rajkote chiefs' college, and its technical institute, and other special institutions, and its Government had attained that eminence by being left free to develop in accordance with local needs and sentiments. In conclusion, he would only thank Lord Lamington for his interesting paper, and leave the field clear for other speakers.

Mr. H. W. WOLFF referred to the subject of credit banks, in connection with which he had been consulted by the India Office before the Credit Societies Act was brought in. He wished to offer his hearty congratulations to Lord Curzon for bringing in that Act, and to all connected with the Government of India for the great success with which the movement had been crowned during the first three years of its existence. All the fears and apprehensions which had been expressed with regard to it had been falsified by events. It was said that the money would be difficult to get, and people had appealed to Government to supply money liberally. Lord Curzon did him the honour to quote him (Mr. Wolff) when bringing in the Bill, by saying that it was on account of his advice that he would not grant more money. A maximum of 50,000 rupees had been granted for every Presidency, which had proved ample. He was in opposition to Lord Lamington's suggestion that powers of recovery should be given. He had the opinion of practical registrars in his favour, who said that Government subsidies were not wanted, nor compulsory recovery through Government agencies. The movement had been taken up very heartily by all classes, and he was glad to say that the educated and well-to-do people had not shrunk from it, even from unlimited liability. Hindu ladies had staked their all on the credit of the bank, and Mussulman landowners had also supported it. The latter knew that the existence of the banks facilitated rent collection, and as it was contrary to the Koran for them to take any interest, they paid the interest given to them to their schools. He was sorry to say, from the reports the registrars sent him, that some of them seemed to be not quite clear as to the ultimate object at which they should aim, but the panchayets had done exceedingly well. Not a penny had been raised by the co-operative banks that had not been well employed, mainly by getting rid of debt to the mahajans, and it was found that the debts which it had seemed hopeless to pay off could be now got rid of in three or four years. A new era was dawning for India. The banks already formed had lent out in three years 37 lakhs of rupees and they had 25 lakhs of assets. There were 735 specifically agricultural credit societies, whose capital amounted to eleven lakhs of rupees, half of which had been subscribed by the members themselves, a quarter had been lent by the Government, and a quarter borrowed from outside. During the last year, loans amounting to nearly 12 lakhs were made, and the total cost of management was only 7,000 rupees. Throughout the year no debts had been written off, and no loss had been sustained, and the reserve at the end of the year amounted to half a lakh of rupees. The movement which had been waited for for so long had, therefore, made a very good beginning. When it was started in Europe, in 1882, many Anglo-Indians, including the late Sir Arthur Cotton, said it was the very thing that India wanted. When once the banks were properly working, he (Mr. Wolff) thought there was ample room in India for co-operation for agricultural purposes. He did not suppose any distributive societies would be wanted in the country districts, but they were beginning to form well organised co-operative productive societies, towards which the national movement had helped. Four thousand silk weavers, who had hitherto been exploited by the middlemen had joined the banks, and if any at home could help them in finding a market for their productions they would be doing a good work. In Egypt agricultural societies had facilitated the purchase of artificial fertilisers; in five years the value of the amount consumed having been raised from £5,000 to £135,000. If the same could be done in India it would be a benefit to the country, and coming generations would bless the name of Lord Curzon.

Lord LAMINGTON, in reply, first of all thanked Lord Midleton for his kindness in taking the chair, and also for the views he had expressed as to the value of the form of government which pertained both in Madras and Bombay. With that opinion he (Lord Lamington) fully agreed. He believed there was room for all the different varieties of administration which were found in India; but he thought that the Governor and Council responded better to Indian ideas than having a single official at the head of affairs. He could only speak from his experience of a particular part of India, but he thought the system in Madras and Bombay was more elastic, and allowed a greater amount of responsible self-government than was to be found elsewhere. He also fully agreed with what Lord Midleton said with regard to decentralisation of work, and that full play should be allowed to local feelings, aspirations and conditions. He also concurred with Sir William Lee-Warner's remarks as to free education. He just mentioned the topic in his paper, but it was rather too dangerous a subject to deal with fully in a paper of the kind he had read. He thought it would be detrimental to the cause of primary education to make it free in India, and he fancied the people of the country valued it far more when they made a small contribution towards the training of their children. He was very pleased indeed that Mr. Wolff had made some remarks on a subject of which he was such a great exponent, co-operative banks, but he was rather surprised at his assertion that he thought it was not necessary to have any form of procedure for more prompt

recovery of sums due to co-operative societies. That had not been the experience in Bombay; and he thought that those who were willing to combine would, perhaps, not feel secure unless they were given some assurance that defaulters would be forced by some summary process to pay up their dues.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Lord Lamington for his interesting paper, and the meeting terminated.

MANCHURIA AND ITS TRADE.

Mr. J. B. Suttor, A.M.Inst.C.E., Commissioner for New South Wales, in the East, has recently reported to his Government on the trade of Manchuria. From this report, it appears that one of the principal crops of the country is millet, of which there are several grades, the most notable being what is called Kao-liang (*Holcus sorghum*), which is the staple food and most important cereal grown in Manchuria. In addition to being used for human food, it is also a grain for animals—such as horses, mules, donkeys, cattle and pigs. Two other kinds of millet are cultivated, but not to the same extent as the variety mentioned. Next to the millets, in importance, is a variety of beans, which is grown to a very large extent. The area under beans is about equal to that occupied by millet, but beans and the products thereof, such as oil and seed-cake, enter more largely than millet into the export trade of China. During 1906, it is estimated that 178,571 tons of bean-cake, 400 tons of bean oil, and 35,714 tons of beans were shipped abroad from the port of Newchwang alone, the statistics of the exports from the other ports not being available. Vermicelli is produced from a bean, known locally as Lu tow (*Phaseolus mungo*), the smallest but one of the beans grown in Manchuria. Wherever one may travel in China, or in adjacent countries inhabited by Chinese, this vermicelli is always largely in evidence. As to the prospects of wheat cultivation, Mr. Suttor is not sanguine. The provinces of Hei-lung-chiang and Kirin—being North and North-Western Manchuria—promise to be the principal wheat-growing centres, especially on the watershed of the Sangari River, but so far he is not aware of any Manchurian wheat yet appearing on the adjacent Oriental markets. As a very rough estimate he would say that not more than 3,000,000 acres are under wheat cultivation in the whole of Manchuria, as compared with, one may perhaps point out, about 29½ million acres under wheat in India. Coal has been found at several places in Manchuria, the most important locality being the Mutsi district, near the ancient capital of Mukden, where some 440,000,000 tons are supposed to be available, the quality being apparently good for steaming purposes. Mr. Suttor is of opinion that owing to the difficulties of haulage and absence of appliances for loading and coaling vessels the Mutsi coal cannot be relied upon to cost less than 20s. or 22s. per ton, f.o.b., for export. Last, but not least, silk forms one of the greatest animal products of Manchuria. During 1906, it is estimated that about 150,000 lbs. of raw silk were exported by sea from Yingkow, but this conveys only a small idea of the magnitude of the trade which, Mr. Suttor says, must be enormous. Manchurian silk is famed from one end of China to the other, being superior to any other quality. Much of the beautiful silk known as Chefoo silk has originally come from Manchuria in the raw state. The cheap silk-growing district is the southern part of the province, bounded by the Yalu and Liao rivers. Only in very rare cases are the worms fed on mulberry leaves. They are almost wholly fed on an oak, peculiar to Manchuria, and known as *Quercus Mongolica*. The young worms are fed, for a short time, on the tender young early shoots of the oak bushes, and when the spinning period arrives, are transferred to the oak bushes themselves to spin their cocoons. The Manchurian silk is often referred to as "wild raw silk." It is worked up to an enormous extent in silks of all shades and colours, which are said to possess more body and durability than the Japanese silks.

EXHIBITION ATTENDANCES.

In connection with the present Franco-British Exhibition it may be interesting to set down for comparison the number of visitors who have attended some of the principal exhibitions in the past, British and foreign. At the 1851 Exhibition there were 6,039,195 visitors, and at that of 1862 6,211,103. The numbers visiting the 1883-6 group of Exhibitions at South Kensington were:—Fisheries, 2,703,051; Health, 4,153,390; Inventions, 3,760,581; Colonial, 5,550,745. At the Military Exhibition, Chelsea, in 1890, there were 923,761; at the Naval in 1891, 2,351,683; at the Liverpool Exhibition in 1886 there were 2,468,098 admissions,; at Newcastle in the same year 2,092,273, and at Edinburgh 2,769,632. The Jubilee Exhibition in 1887 at Manchester attracted 4,765,137; the number at Glasgow in the following year is given at about 5½ millions. At Glasgow, in 1901, there were 11,559,649, by far the largest number recorded at any British exhibition. This number has, of course, been largely surpassed at the more recent great International Exhibitions. Paris holds the record with 25,398,609 in 1889, and 37,287,682 in 1900. Chicago (1893) was next with 21,477,212, but it should be remembered that at Chicago the admission fee was half-a-dollar (two shillings), whereas at Paris the actual cost of a ticket was always less than a franc, and was sometimes in 1889 half that amount. The number of visitors to St. Louis (1904) was reported at about 19 millions.

ARTS AND CRAFTS.

Hungarian Decorative Art.—We in London are rather apt to look upon the Earl's Court Exhibition as a place of amusement and side-shows—and not without reason—and to forget that the foreign countries which contribute to the exhibitions there take them seriously, and send us of their best if we only seek it out. This is especially well worth doing in the case of the Hungarian Exhibition. It has been well known over here for some years past that Hungary intended to excel in (amongst other things) the decorative arts. Not only has she exhibited at the great international exhibitions, but she has organised at least one exhibition of British applied art at Budapest, and has been doing her best to know what was being done all over Europe, and to keep up with more Western lands in the modernity of her productions. Only three or four years ago, though the people were proud enough of their old national arts and crafts, the feeling—at least, in the capital—seemed all in favour of a type of design in which tradition, national or European, played little or no part. A wave of feeling, or even of fashion, does not exhaust itself in three or four years, neither does it disappear leaving no trace behind it. But it would be difficult to-day for a visitor to Earl's Court who knew nothing of the history of applied art in Hungary during the past ten years, to believe that the *art nouveau* had taken such complete hold of it as it seemed to have done a few years ago—though the exhibit of the painters and weavers of Gödöllö (which has a room to itself at the beginning of the Fine Art Section) is as modern as anything could very well be; and there is a feeling of restless effort, which is not altogether pleasing, about some of the exhibits of the Royal Hungarian School of Decorative Art at Budapest. On the whole, however, though the work of M. Lalique and other modern French jewellers has evidently had some influence in Hungary, and though there is evidence in other directions of a certain striving after what is new, there seems to be a very decided reaction towards traditional types. The desire of the Magyars to assert themselves as a nation, and to preserve or inculcate a national spirit, has been leading them apparently to look for inspiration in art, as in other things, to old Hungarian models—and with very happy results. There is a great deal of work shown at the Hungarian Exhibition which, whether done by peasants at home under the direction of philanthropically and patriotically disposed ladies, or turned out by the students in the various kinds of schools, shows what excellent results can be got by people who are content to work on traditional lines and make them almost, by the way, their own. In the Educational Section a good deal of embroidery is shown, and in this the traditional character of the work is on the whole so clearly marked that it is possible for anyone who has a fair knowledge of the kind of peasant work produced in the different parts of the country to tell in many cases approximately from what part the exhibits come. This is not always made very clear by the labels, at any rate to the average Briton, whose knowledge of geography is not very great to start with, and who is further handicapped in this case by not knowing the Magyar equivalent for places with which he is quite familiar by their German names.

Leatherwork.—Hungary is, as we know, pre-eminently a cattle raising land, hides are abundant there; and it is interesting to see how large a part leatherwork plays in the exhibits. There is little or no tooled leather, but the traditional work of the country is represented by a very pleasing little casket covered with leather and decorated with ornament in *appliqué* leather, sewn with a leather tape or thread. The greater part of the leather exhibits, however, consists of work which, though often typically Hungarian in design, is, so far as craftsmanship is concerned, borrowed immediately from Holland; though it comes of course, originally from the Indies. There are several chairs and a number of smaller things in coloured (very often blue) leather on which is a pattern in golden brown. The work is rather puzzling at first sight—it seems almost impossible to tell exactly how it is done. It turns out, however, to be batik work on leather. Something of the same kind has been done in Holland, and has been shown at exhibitions abroad, but this Hungarian work—though it owes its origin to a Dutch source—is much more coherent in design than the Dutch work, which retained a good deal of the savage quality of the Javanese model. The specimens of batik work on leather shown at Earl's Court are by no means merely savage (if a little barbaric in effect), and they give the impression that the artist got pretty much what he was aiming at and was not working in the dark or trusting that a lucky chance would enable him to get a happy effect. As a method of decorating leather, this appears to be far more satisfactory than any form of flat surface treatment that has yet been attempted.

Jewellery and Silversmiths' Work.—The jewellery and silversmiths' work generally is happiest when it runs fairly closely on the old lines. There are a few not unpleasing pieces of work which are obviously founded on the fashions which have been prevailing elsewhere, but the most attractive things are those which are reminiscent rather of the famous Hungarian *drahtemail*, or wire enamel, of the sixteenth century than of a foreign or modern influence. This kind of work has all the charm of the jewellery which is being made in large quantities at the present time, mainly of bent silver wire and stones, and is, moreover, far more solidly fashioned. There is, too, a sort of semi-barbarous magnificence about it—a quality which is necessarily lacking in work produced in civilised lands to-day except where it has been consciously or unconsciously founded upon tradition.

Pottery.—Hungarian pottery means to most of us, naturally enough, neither more or less than the work

of Messrs. Zsolnay of Pecs. Their delicately-painted lustre ware was a feature of the Hungarian section of the Paris Exhibition of 1900. Since then they have been turning their attention to a showier and, in some ways, less satisfactory kind of work. There is, indeed, something very striking in the brilliant red lustre which compels attention, from no matter what distance, but it is too often used on forms far from pleasing in themselves, and not improved by being made conspicuous. There was, a few years back, a feeling of restlessness about a great deal of the work produced — as though the makers were trying for something which just didn't quite "come off." To-day, more sober taste seems to prevail. The beauty of the red and purple lustre is no longer marred, save in occasional instances, by eccentricity of form—and if the very minute painting of ten years ago has gone, never to return, its place has been taken by work which is at least delicate and refined, while it has the merit of being sold at a price which is by no means exorbitant. The "Original Studies in Majolica" of Professor Vincent Wartha, shown in the Educational Section are extraordinarily spotty in effect—and the pottery exhibits of the School of Industrial Drawing, of the city of Budapest, are in no way peculiarly interesting. It seems rather odd that in a country that produces on the one hand the finished work turned out by Zsolnay, and on the other a quantity of peasant ware which in its own rough way is pretty, pleasing and very characteristic, the work of the schools should be neither tasteful nor conspicuously national in design.

Furniture.—The furniture is a very satisfactory feature of the Exhibition. What is shown comes largely from reformatory schools, and it speaks well for those who are responsible for it. It is simple in form, and made practically without mouldings. In short, it is quite modern in type, with no affectation of any particular style, but with a simple dignity of its own which would make it pleasant to live with. The wooden chairs in the Forestry Section are good in form and very comfortable to sit upon, and both the pillars in this court and the furniture in the Educational Section are decorated with a sort of bold chip-carving in a very simple and satisfactory way. The brightly painted peasant furniture in the Hungarian street is refreshing and attractive enough in the surroundings for which it was made—but it would hardly fit into the conditions of more sophisticated life.

Embroidery.—Of the embroidery it would be difficult to speak at length within the limits of these columns. There is an enormous quantity of it, and the quality is excellent. It is mainly of a traditional type—either the work of peasants who have for generations worked approximately the same patterns in more or less the same way, or schoolwork done on the old lines, or work executed under the supervision of the national Home Arts Society, which is trying to make the work of the peasants available for the dwellers in the towns. The Society is to be congratulated on having turned out work which, while it is quite distinctively Hungarian and quite obviously of peasant origin, is neither too barbaric nor too rude, nor too garish to be used effectively in modern costume: it is not so easy as it would appear to turn peasant work to artistic and commercial use at the present day without to a great extent losing its character. There is work from all parts of Hungary, including Croatia and Slavonia—some of it Eastern and some Western in design, and it is executed in widely different stitches and materials and by a great variety of methods. The modern work is supplemented by an interesting collection of old work. A needleworker who found nothing to interest her in the exhibition would be hard, indeed, to please.

OBITUARY.

George Matthews Arnold, J.P.—Mr. Arnold died on Thursday, 29th May, at his residence, Milton-hall, Gravesend, at the age of 81 years. He was the eldest son of Mr. Robert Coles Arnold, J.P. for the counties of Sussex and Kent, and brother of the late Sir Edwin Arnold. Mr. Arnold was eight times Mayor of Gravesend, and his gifts to the town included the Gordon Memorial Pleasure-grounds. He was the author of a number of historical and archæological works, and his museum, housed in a building near his residence, contains one of the best collections of local and other antiquities in the county of Kent. Mr. Arnold was elected a member of the Society of Arts in 1891.

Sir John Evans, K.C.B., D.C.L., LL.D., D.Sc., F.R.S.—The Royal Society of Arts has lost a distinguished member in the person of Sir John Evans, who died at Britwell, near Berkhamstead, on Sunday, May 31st. He was elected in the year 1860, and took much interest in the proceedings of the Society. He contributed a paper to the National Water Supply Conference in May, 1878, and joined in the discussions at the Conference on National Water Supply, Sewage and Health in the following year. He was a Vice-President of the Society from 1898 to 1901, and occupied the position of Chairman of the Council 1900-1; when he delivered the Chairman's address on November 21, 1900, on the "Origin, Development, and Aims of Scientific Societies."

The particulars of Sir John Evans's distinguished career are well-known, and need only be shortly referred to here. He was born in 1823 at Britwell-

court, Bucks, the son of the Rev. Arthur Benoni Evans, head master of Market Bosworth school. He obtained his education under his father at this school, and was entered for matriculation at Brasenose, but an early call to business changed his career. Some sixty years subsequently he was elected to an Honorary Fellowship of this college, which gave him much gratification. His mother was a Dickenson, and he commenced his business life with the well-known firm of John Dickenson and Co., paper manufacturers, of Nash Mills, Hemel Hempstead, with which firm he was connected all his life. At the residence adjoining to the works he lived for more than fifty years.

His first published work was on "The Coins of the Ancient Britons," which appeared in 1864, a supplement being added in 1890. He joined the Numismatic Society in 1849, and became its honorary secretary in 1854, holding that office until 1874, when he was elected President, an office which he retained until his death.

Sir John studied geology from his youth, and early turned his attention to the relation of geological structures to water supply. He was one of the first geologists in this country to appreciate the far reaching importance of the discovery of flint instruments and its bearing on the prehistoric condition of man. In 1872 he published his monumental work on "The Ancient Stone Implements, Weapons, and Ornaments of Great Britain," a second edition of which appeared in 1897. In 1881 he published "Ancient Bronze Implements, Weapons, and Ornaments."

In 1874 he was elected President of the Geological Society, and in successive years he filled the same office in several of the chief English societies, viz., the Anthropological Institute in 1877, the Society of Antiquaries in 1885, the Institution of Chemical Industry in 1892, the British Association in 1897, and the Egypt Exploration Fund in 1899. He was a correspondent of the Institute of France, a Trustee of the British Museum, and Treasurer of the Royal Society from 1878 to 1898; also Chairman of the Lawes Agricultural Trust Committee.

The writer of a full and appreciative obituary notice in *The Times* says: "Perhaps few of those who were brought into intellectual contact with his extraordinary range of scientific and archæological interests, ever knew him as a paper manufacturer; but the fact remains that he was a business man from first to last, and that his capacity for business, both public and private, was of a very high order indeed." The same may be affirmed as regards his local interests. The writer already quoted, says: "His name would have been a household word throughout the county of Hertford, even if it had never been heard of in London, or in the larger world of letters and of science." He was High Sheriff of the county in 1881, and for several years he occupied the posts of Chairman of Quarter Sessions, and Chairman of the County Council, with general satisfaction.

GENERAL NOTES.

Rubber in Java.—A good deal of interest continues to be shown in the cultivation of rubber-producing trees throughout Netherlands India, and the suitability of the climate and soil, together with the labour advantages which Java possesses over most tropical countries, has resulted in considerable and increasing European capital being put into rubber enterprises there. According to statistics lately compiled, the capital of British companies interested in rubber in the Dutch East Indies, but domiciled in the United Kingdom, amounted to nearly £1,500,000. This, however, does not include the numerous companies formed during the last few years, also with British capital, but domiciled in Java, which may be estimated at another £250,000. The first conference of rubber planters was held in October last, at which it was resolved to institute an experimental station with nurseries, which Mr. Consul Stewart, reporting upon the trade and commerce of the island (Annual Series No. 3991) thinks should prove valuable to rubber planters. The area at present under cultivation is estimated at some 58,000 acres in Java, 25,000 acres in Sumatra, and 7,000 acres in Borneo, of which most of the older rubber, and nearly all that is in bearing (say one-half of the whole acreage) must be *Ficus elastica*, as the cultivation of the Para variety dates only from 1905 onwards. At present exports are still inconsiderable, but in the course of a few years the Dutch East Indies are likely to prove an important factor in the rubber markets of Europe.

MEETINGS FOR THE ENSUING WEEK.

Tuesday, June 9...Faraday Society, 92, Victoria-street, S.W., 8 p.m. Dr. Albert R. Frank, "The Utilisation of Atmospheric Nitrogen in the Production of Calcium Cyanide and its use in Agriculture and Chemistry."

Wednesday, June 10...Biblical Archæology, 37, Great Russell-street, W.C., 4½ p.m.

Thursday, June 11...East India Association, Caxton-hall, Westminster, S.W., 4 pm. Mr. Rosher James, "The Implications of University Reform in Bengal."

Mathematical, 22, Albemarle-street, W., 5½ p.m.

Friday, June 12...Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Paper on "Animals in Art."

Astronomical, Burlington-house, 5 p.m.

Physical, Royal College of Science, South Kensington, S.W., 8 p.m. 1. Messrs. Bellini and Tosi, "Experiments on a Directive System of Wireless Telegraphy." 3. Dr. Morrow, "The Lateral Vibration and Deflection of Clamped-directed Bars." 3. Professor Lees, "The Resistance of a Conductor of Uniform Thickness whose Breadth suddenly Changes, and on the Shapes of the Stream-lines." 4. Dr. Nicholson, "The Self-Inductance of Two Parallel Wires." 5. Dr. Barkla and Mr. Sadler, "Homogeneous Secondary Radiation." 6. Professor Morton, "Notes on the Motion of a Corpuscle a d on Cloud Formation."

Journal of the Royal Society of Arts

No. 2,899. VOL. LVI.

FRIDAY, JUNE 12, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Fifty-fourth Annual General Meeting for the purpose of receiving the Council's Report and Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held in accordance with the By-laws on Wednesday, 24th June, at 4 p.m.

(By Order of the Council),

HENRY TRUEMAN WOOD,
Secretary.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Thursday evening, July 2nd, from 9 to 12 p.m.

The Reception, by Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert, under the direction of Mr. Harry Tipper, will be given in the Reptilia Gallery from 9.15 till 10.15 p.m., and from 10.30 till 11.30 p.m.

A Gramophone and Auxetophone Concert, under the direction of the Gramophone Company, will be given at the Western End of the Bird Gallery at intervals from 9.15 p.m.

The following portions of the Museum will be open :—

The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions ; protective resemblance, &c. Also models of the Tsetse-Fly, the Malaria Mosquito, and the life history of the Malaria Parasite. A splendid specimen of the Sea Elephant has recently been placed on exhibition here.

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests ; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrated Animals of the British Isles.

The Gallery containing the Reptiles, including the three gigantic fossil forms *Diplodocus* and *Triceratops* from Wyoming, U.S.A., and *Iguanodon* from Bernissart, Belgium.

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Visitors travelling by District Railway (or other underground railways in connection) will be allowed free use of the Company's Subway, which leads from the South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the day of the conversazione. On that date the price will be 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the

Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

A programme of the arrangements for the evening will be published in due course.

PROCEEDINGS OF THE SOCIETY.

SHAW LECTURES ON INDUSTRIAL HYGIENE—V.

Delivered on March 17, 1908.

CHILD WORKERS AND WAGE-EARNERS.

By Miss Nettie Adler
(Honorary Secretary to the Committee on Wage-earning Children).

The position of the child in our scheme of social economics is now recognised to be of such vital importance as to be above politics and party. Not only is our present standard of life gauged by the welfare and happiness of our boys and girls, but as one of the most brilliant of our contemporary writers has recently said, "the whole measure of progress in a generation is the measure in which the children improve in physical and mental quality, in social co-ordination, in opportunity, upon their parents."* It is the purpose of this lecture to place before you certain conditions in our social order, which it is believed militate, to a very grave extent, against the mental and physical welfare of large numbers of children throughout the country, to show what steps have already been taken to combat the evil, and to suggest further measures for removing, or for at least diminishing, those undesirable aspects of child life, which damage and hinder the development of the younger generation.

* "New Worlds for Old," by H. G. Wells. Constable, 1908, p. 28.

There is a very widespread impression existing, even among well-informed social workers, that the compulsory Education Acts, 1876-1900, killed all juvenile labour, that the half-time system has been abolished, and that the Employment of Children Act, 1903, put an end to the drudgery found among children employed in unregulated industries. This is, unfortunately, not the case. The age for half-time work has certainly been raised by a series of enactments from ten to twelve years, the standard for total exemption has in many districts been fixed at the seventh, some of the largest and most progressive cities of the kingdom, notably London, Liverpool, and Bristol, have prohibited half-time employment altogether. But on the other hand, half-time employment, more especially in the textile manufacturing districts, has increased during recent years by leaps and bounds. The last returns published in the Report of the Board of Education for 1906-7* show that 82,328 children were working as partial exemption scholars in 1905-6 against 80,328 in 1904-5, and 78,876 in 1903-4. The Annual Report of the Chief Inspector of Factories and Workshops also shows that 42,613 children† were examined for certificates of fitness in the United Kingdom during that year, in order to enable them to be employed as half-timers. Of this number 23,728 were to work in Lancashire and 10,063 in Yorkshire. These figures, however, do not by any means exhaust the number of children engaged in various occupations and yet attending school. Besides the total of 82,328 half-timers noted in the Report of the Board of Education, it is estimated that there are at least 200,000 children attending school full time and working out of school hours, early in the morning and late in the evening, at a variety of occupations ranging from street trading, milk selling, and shop errands to domestic work and home industries.

We will consider first the case of the half-timers, more especially the boys and girls who are employed in textile factories, mainly in the cotton and woollen spinning and weaving industries.

The present activity in the cotton trade has been partially responsible for the increase in the number of young children employed in factories. Knowing that employment is assured to them as soon as the age of twelve years is

* Cd. 3862, 1907, p. 40. Wyman and Sons, Fetter-lane.

† "Factory and Workshops Annual Report for 1906." Cd. 3586, 1907, Wyman and Sons, p. 360.

attained, parents rush to the school even before that age is reached, securing the necessary figures from the head teacher, showing that 300 attendances* have been made in each of five preceding years and ask for the partial exemption of their child. And so all effective education is cut off just at the moment when the child begins to realise the value and interest of learning. For what does the half-time system involve? It means that every alternate week in the year, rain or sunshine, the children must be wakened at five or a little after, in order to arrive at the factory by six o'clock, or in some instances at half-past six. It means that for six months of the year they must leave home and walk often a mile or more through the raw mist, the cold and the darkness, so typical of a North of England town. It means that they will stay in the factory until twelve or half-past twelve, with half-an-hour's interval for breakfast, a breakfast composed of bread and butter and tea without milk, taken at the loom side. It means that at twelve or half-past, they run home for a midday meal, the more tidy and respectable to change their oil-sodden, ill-smelling factory clothes for neater garments, to snatch a hurried meal and to be in school by two o'clock. After a long morning, begun when most of us are asleep, at lugging bobbins, doffing bobbins, laying on bobbins in the spinning-rooms, or tenting in the weaving-sheds, can you wonder that the children find it hard to concentrate their minds on the mysteries of arithmetic and grammar? In the following week the children go to work in the afternoon shift. This entails school attendance from nine till twelve o'clock, a wild rush home for dinner, and attendance at the factory from a quarter-past one until a quarter-past five or a quarter to six; the hour of ceasing work depending on the hour at which the looms are started in the morning. The total number of hours worked gives a weekly average of about 27½ hours. Saturday morning work is only permitted to be done on alternate Saturdays.†

What is the effect on the children, educationally and physically?

It is easier to reply to the first, than to the second question. Educationally, the effect is disastrous. Recently, during an inquiry made in two of the most important centres of the cotton and woollen industries, I was enabled, not only to see the children at work in the factories, but to visit a considerable number of schools, and to interview both teachers and children. In one town, I visited six large Council schools, all of which contained an average of from 100 to 150 half-timers. Fifty per cent. of the children at work, in the upper classes, were half-timers; in some schools, even more. In one class I found 49, out of 56 girls, half-timers—only 7 being present the whole day. In another, the proportion was 36 out of 55; in another, 14 out of 27; in another, 20 out of 40. The children are not all present at the same time, some being engaged in the morning shift, others in the afternoon, consequently continuity of teaching is only secured with difficulty. In some schools it has been found possible to provide special classes for the half-timers, so as to preserve a continuous curriculum; but while this can be sometimes organised for children in the upper classes, where there are large numbers of partial exemption scholars, this cannot be arranged for the boys and girls scattered among Standards II., III., and IV., who woefully need all the educational advantages that can be afforded them. But in every instance, the teachers say, the children lose more than 50 per cent. of their education. When they come to the school after the morning shift, 33 per cent. are in a semi-comatose condition, quite unable to profit educationally from the lessons put before them, and more often than not they fall asleep in school during the afternoon. This is hardly to be wondered at when we remember that the children are almost entirely employed in the spinning-rooms (more than 4,000 out of a total of 5,093 half-timers in Bradford alone), and in a very hot and highly humid atmosphere. The monotony of the work, the noise and the smell, all affect the children prejudicially and make them less responsive intellectually. Morally the effect is also undesirable. They become less inclined to discipline and rougher in manner. Teachers consider that the whole moral tone is lowered, and that there is visible deterioration which is most heart-breaking. It should be added that, as a rule, half-timers work with the spinners, who seem to be the more unskilled and less intelligent of the factory workers. In visiting evening schools in the same town, it was easy to differentiate by the appearance between those who were engaged in spinning or at the more skilled employments of weaving or burling. Reference to the admission register

* "Elementary Education Act, 1899."

† Section 25, sub-section 5, "Factory and Workshops Act, 1901."

almost always showed that surmise had proved correct.

Physically the results must be equally bad, but no carefully organised system of enquiry has so far been undertaken. Dr. Crowley, the Medical Officer of the Bradford Education Committee, however, recently obtained replies from 52 head teachers regarding the physical effect of half-time work on the children in their schools; 37 declared that the system was most injurious to the child's physique, they considered that the lack of adequate sleep, the constant pressure to work quickly, the carrying of big loads of bobbins about the factory, the morning tea without milk, the heat of the spinning-rooms, the lack of play, all worked harm. The rush from school to the mill is undesirable, for there is little time for eating or digestion. Certainly a stranger is impressed by the par-boiled look, the pallid faces, the bulging foreheads, the thin, undersized bodies, the blue lines under the eyes; and he feels that the price paid for this premature work will indeed be a heavy one in later life. But there is danger, too, to the overtired, listless children in the swiftly running looms. Accidents are still, unfortunately, too frequent. Thus, in the hosiery mills during 1906, out of 109 accidents, 16 occurred to children of 13 years!* A little girl of thirteen years had her hand drawn in by rollers and a boy of the same age lost a finger. In another instance a little girl of thirteen was crushed between the mule and the fixed portion of the machine.†

It will be asked, Does the factory work help these children in their after life? From enquiries made among a large number of boys who had been half-timers and were now working full time in the factory, it would seem that very few intended to remain in the factory, or could do so if they wished—at least in the woollen trade. A small proportion become overlookers, but at sixteen they often have to leave and find other employment, and sometimes this is a matter of much difficulty. The demand for girls is much greater, but there does not appear to be any technically educative element—a preparation for after life in the almost mechanical work of taking off and putting on bobbins, or twisting together the loose ends of cotton or woollen threads. It must not be thought, however, that many of the children, or even a majority of them, dislike the work, or think themselves hardly used. The days of the strap and the branding-iron are fortunately gone for ever. Many of these boys and girls are glad to be independent, to have pocket-money, "spence" as it is called, or to add to the falling budget. The average earnings are from 2s. 6d. to 4s. 6d. weekly. Many of the children also prefer to work in the early morning shift, despite the early rising entailed. But because the children are not unhappy, this is no argument that a harmful system should be continued. The more enlightened employers regard the half-time system as a "bad convention." Many of the newest and finest mills do not employ these young workers. Many mill-owners say that premature juvenile labour is economically bad, and that it is unnecessary from the point of view of the family budget. Many too, are of opinion that if the system were swept away to-morrow, no dislocation of industry would be involved. The effect would, no doubt, be to reduce unemployment, for cheap child labour is at present taking the place of adult effort. But these views are not held, by any means, unanimously among employers, and it is to be feared, too, that opposition to reform would come also from parents. "Our mithers and faethers are main hard after the bawbees," said an old North country worker to me in the course of my investigations. But twelve years has remained the age for half-time exemption for the past nine years, and it is surely time now to raise the age to thirteen years. This would do much towards destroying this relic of a less civilised era.

So far we have been dealing entirely with the children engaged in industries which are regulated and safeguarded by inspection, and by the Factory Act. There are, however, a vast number of occupations which, until recently, have not been subjected to any system of regulation, and in which children have been employed, while attending school full time. A great deal of over-pressure and overwork has severely handicapped these "little white slaves" for the battle of life. As will be shown later on, happier conditions will, no doubt, be possible in the future, when local authorities shall have taken full advantage of their powers under the Employment of Children Act. But large numbers of children are still working for long hours in nearly all big towns, carrying parcels for tradesmen, acting as little drudges in small households, selling papers or flowers in the street, or working at home industries.

The extent to which children were employed in unregulated industries was first brought to

* "Factories, and Workshops Annual Report for 1906," p. 208.

† "Factories and Workshops Report for 1906," p. 208.

public notice by the late Mrs. F. G. Hagg, in an article in the "Nineteenth Century" for August, 1897. With the help of the Women's Industrial Council she organised a deputation to Sir John Gorst, then Minister of Education, with the object of asking him to institute a Parliamentary inquiry into the number of children employed whilst attending school full time. As a result of this action a return was obtained from elementary schools in England and Wales, showing the number of children employed, the hours worked, their ages and occupations and the pay received. The return was by no means complete, as only the names of children in regular employment and in receipt of wages were included in the schedules. Moreover, in many instances no information was forwarded, where the work carried on was not regarded as prejudicial to health. Employment which occurred during school hours and was consequently illegal was also omitted. Full information was received up to May, 1899, regarding 144,026* children. In 16,489 instances the cases investigated were stated to be those of children under ten years of age; 39,969 boys and girls were shown to be working for more than twenty hours weekly. These facts made a painful impression on the country, and in commenting upon them in the House of Commons, Sir John Gorst described the publication as a "painful and sickening document," and as throwing "a lurid light upon the social condition of large classes of the population."

The need for further investigation having been clearly demonstrated, an Inter-Departmental Committee was appointed by Mr. Ritchie in January, 1901, composed of Commissioners representing the Home Office, the Board of Education, and the Board of Trade. Among the witnesses examined were members of the London and other great School Boards, the Public Control officer of the London County Council, representatives of trade associations interested in the employment of child labour, school teachers, managers and attendance officers. The results of certain independent investigations undertaken since the issue of the Parliamentary return were also placed before the Commissioners, and these all tended to show that the statistics given in that paper fell far short of the number actually employed.

* "Elementary Schools (children working for wages.)" Part I., 1899. Eyre and Spottiswoode, East Harding-street, E.C., see pp. 36 and 47. The names of 8,323 children were subsequently received, making a total of 147,349 children employed.

Whereas only 4 per cent. of the children in attendance in the year 1898 were returned as wage-earners, the figures presented by Mr. Hance, the Clerk of the London School Board, demonstrated that nearly $7\frac{1}{2}$ per cent. attending Liverpool schools were being employed during the spring of 1901. The Committee on Wage-earning Children secured the investigation of 3,897 cases in 107 London schools, with an average attendance of 42,097, and found that the proportion of wage-earners was 9 per cent., or if calculated from the number on the roll 8 per cent. The Parliamentary Return had only shown $6\frac{1}{2}$ per cent. at work in London. *The Inter-Departmental Committee were therefore of opinion that 200,000 children represented a fair average of the number of children attending school full time and working out of school hours. They took 100,000 as the number of half-time employed in the year 1898, arriving at a total of 300,000† children who were in attendance at school, and also in paid employment in that year.

It has been already shown that the number of half-timers employed is still well over 82,000. From recent enquiries which have been made, it does not appear that in London and other largely populated areas the number of children attending school full time and working for wages has sensibly diminished. Typical London schools have been investigated at intervals, and similar investigations have also been made by local authorities anxious to enforce the Employment of Children Act. Thus, in the summer of 1905 Dr. Thomas, the Assistant Medical Officer of the London County Council Education Department, made an investigation into the cases of 400 boys, representing an attendance of 3,674 children.‡ This gives a percentage of about 13 per cent., more than double the percentage shown by the Parliamentary Return. In an investigation made last year in a Hackney school, 5 per cent. of the girls attending one department were found to be engaged in home industries alone. Quite recently, enquiries made at a school in North-East London revealed the fact that 60 boys out of a roll of 430 were working out of school hours, and at a South London school an enquiry carried on in a girls' depart-

* "Report of the Inter-Departmental Committee on the Employment of School Children." Cd. 819. 1901. Price 3s. Eyre and Spottiswoode.

† "Report of Inter-Departmental Committee." p. 9.

‡ "Report of the Medical Officer for Education, London County Council," March 31, 1906, pp. 21 and 22. No. 197. P. S. King. Price 1s.

ment showed that 23 out of 227 children were employed. An investigation undertaken last year by the Hornsey Education Committee resulted in 9 per cent. of the children in the schools of that authority (1,228 out of a roll of 22,226) being returned as working for wages. At Brighton, during May, 1906, a similar enquiry was made, 811 children on a roll of 16,374 being found to be similarly employed: a large number, when we remember that Brighton cannot be regarded as a great industrial centre. Another recent return from a semi-rural district, Erith, showed that 267 children out of a roll of 5,358, or about 5 per cent., were being employed. All the figures given demonstrate, that the problem has so far not diminished since the results of the Parliamentary inquiry were published, and that the subject merits the gravest consideration.

It will be asked, how are these children employed? Their occupations may be roughly classified under four heads:—

1. Children employed in or for shops.
2. Children engaged in street trading.
3. Children employed in domestic work and home industries.
4. Children employed in agriculture.

The Parliamentary return for 1899 showed that 76,173* children out of a total of 144,026, or rather more than one-half, were employed in or for shops. So far as can be ascertained from recent inquiries in individual schools, the proportion remains about the same. The evidence submitted by Mr. Spencer, the Public Control officer of the London County Council, before the Inter-Departmental Committee on the Employment of School Children, in 1901,† gave important details as to the number of hours worked by school boys engaged by shopkeepers. One thousand four hundred and forty-eight typical cases were submitted which had come under the notice of the shop hours inspectors of the Council. Of this number, 492 were found to be working under 20 hours weekly, 413 from 20 to 30 hours weekly, 446 from 30 to 39 hours, 87 from 40 to 49 hours, and ten for fifty hours and upwards; 529 of these boys were described as working for dairies, an employment which necessitates two hours work before morning school, and, in wet weather, a long morning's sitting in damp garments. Most undesirable of all occupations is that of lathering in a barber's shop.

* "Children Working for Wages," Table iv., p. 43.

† "Minutes of Evidence taken before the Inter-Departmental Committee on the Employment of School Children, 1902" (Cd. 895), pp. 84, 85, 86, 87, and 88.

Mr. Spencer estimated that the number of boys employed in London at this work was 619.* The long confinement in a vitiated atmosphere is injurious physically. Moreover, some of the witnesses who gave evidence before the Inter-Departmental Committee were of opinion that these establishments were not infrequently used for betting and gambling transactions.

About 12 per cent., or 17,617† of the total number of children employed are described in the Parliamentary return as engaged in street trading—either selling newspapers or hawking goods. The Commissioners stated in their report‡ that they were of opinion that "this work is carried on by a worse class of children, and under worse influences than any other, that it is especially detrimental to young girls, and that in large centres of population it requires special treatment." Street traders nearly always come from the poorest homes, and we may probably regard as typical the home circumstances of 134 street traders investigated by the Manchester police in 1901. In 54 instances, either the father or mother, and in some cases both parents, were addicted to drink, and in a considerable number of instances it was shown that there had been difficulties in the home—such as separation or desertion.§ In only 27 families were the parents returned as "steady." The Chief Constable also put on evidence a list of persons who had formerly been street hawkers, but were now known as degraded characters. The Chief Constable of Birmingham also gave important evidence, showing that out of 713 boys and girls found selling in the streets of that city in March, 1901‖, 458, or nearly two-thirds of the whole number had been prosecuted for various offences within the previous six months; 115 of these young people were charged with felony and 185 with gambling. That street traders are a difficult tribe to deal with may be judged from the fact that in the Annual Report of the Chief Constable of Newcastle-on-Tyne for 1907,¶ out of a total of 1,411 children and young persons under sixteen years who had been granted street trading licenses, 250 were proceeded against during the past year for infringement of the street-

* "Minutes of Evidence," p. 85.

† "Children Working for Wages," p. 43.

‡ "Report of the Inter-Departmental Committee," p. 16.

§ "Minutes of Evidence," p. 450.

‖ "Minutes of Evidence," p. 471.

¶ "Report of the Police Establishment, Newcastle-on-Tyne, 1907," p. 8; ditto, ditto, p. 27.

trading by-laws. The report for 1907 issued by the Medical Officer of Health for Brighton, contains remarks regarding street trading which are well worth quoting, and which show that in spite of the operation of by-laws nothing short of total prohibition can remove the serious consequences to the children concerned.

"Street trading," says Dr. Newsholme, "has a pernicious effect on the boys engaged in it. There is first the evil physical influence of excessive fatigue during the years of growth. This is more marked in street trading than in employment under other by-laws of this Act ("The Employment of Children Act"). The ulterior consequences are even more serious. The children employed as street traders are brought into contact with the adult class of street traders, their moral standard is endangered and they are apt to drift into the large class of those who never have any other than casual employment throughout their lives. It is a great pity that under the present law street trading by boys cannot be entirely forbidden."*

This very definite opinion reiterates the view expressed over and over again by witnesses who gave evidence before the Inter-Departmental Committee that "once a street trader always a street trader," and that the army of unemployed and unemployables is largely recruited from these young people. All witnesses held the view unanimously that street trading by girls led to deplorable results and should be entirely prohibited.†

The case of children engaged in home industries has recently received a good deal of attention owing to the Select Committee on Home Work which reported last August, and also to the interest aroused by the various Sweated Industries Exhibitions which have been held in several large towns. The Parliamentary Return showed that 35,494‡ children were engaged in various forms of domestic work in 1898, but it is difficult to determine how many of these were engaged in some form of industry also. In the introductory memorandum of the Return, 12,646 children are shown to be engaged in piece-work, such as brush-making, basket-making, matchbox-making, rag-sorting, while 4,019§ girls were shown to be employed in dressmaking, shirt-making, mantle-making, tailoring, beading, belt-making, and other similar occupations. In certain districts of London, more especially in the north and north-west of Bethnal Green-road, small girls are constantly employed in home industries. Not long ago, I was told by the head teacher of a large school in that neighbourhood, that the parents refused to allow their children to take advantage of the Fresh Air and the Children's Country Holiday Funds, because they were so glad to have their labour during the vacations.

You may be interested in hearing notes of personal investigations among these little home workers.

Jane R., aged ten, and her sister aged six. Father a porter. Mother makes hair-pin boxes 5d. a gross. The children work directly they come home from school and again after school. Two tiny rooms, in the front one, where the mother is employed, is a big bedstead with scarcely any covering. Two whimpering infants lie upon it—one is two years old, but he looks no older than the baby of two months. The floor is grey with paste and dirt. Jane can "corner-up" and fold the edges of boxes as deftly as her mother. Asked why she is obliged to work, Mrs. S. says that her husband's money is only 22s. weekly, and that is not enough to keep them on, for there is 8s. 6d. rent to pay. So far as one could see, there was no evidence of drink, and the mother appeared to be a woman of some refinement of manner.

Louisa C , age 13, does trouser finishing, sews on buttons, and helps in finishing. She can sew 11 buttons in 10 minutes. Works from 7 a.m. till school time and again from 7 p.m. to 11 p.m. in the evenings. Her mother receives 2¾d. per pair for making buttonholes, back holes, bands, linings, facings, and for pressing. Mrs. C. can manage about six to a dozen pairs daily; one pair takes half-an-hour to make, sometimes longer.

Numbers of these children not only paste socks in babies' shoes, finish match-boxes and trousers, cover and "fan" steels, and sew fish baskets (work of a particularly disagreeable character, which the little girls complain causes pain in the process of manipulation), but they go to "shop" too, and are consequently often late for school. This also frequently involves the carrying of heavy weights. Some of the worst cases of over-pressure have occurred in the provinces among the hook and eye card sewers of Birmingham and the lace workers of Nottingham. The last report of the Chief

* "Report of the Medical Officer of Health for Brighton, 1907," p. 71. See also pp. 68, 69, and 70.

† "Minutes of Evidence," p. 275 (letters rom Newcastle and Nottingham Town Councils) See also pp. 123, 131, 137, 153, 163, 175, 180, 196, 214, and 253.

‡ "Children Working for Wages," p. 43.

§ "Children Working for Wages," pp. 23 and 25.

Inspector of Factories and Workshops contains some very sad instances brought to light by Miss Squires, one of the lady factory inspectors working at Nottingham. She says:—

"From the facts that came to light in visiting the schools and homes of the children, it seems that the teachers' complaints that the school children are 'little slaves' is not unfounded. The teachers told me of children of from 5-11 years being employed at home during the dinner-hour, and I found such a case myself. A little girl of eight, still in her hat and jacket, was at 1.30 drawing lace 'for mother'; she had not had dinner, and would probably eat it on her way back to school. The lace drawing and clipping is a notoriously badly-sweated industry. I visited several most sad homes this last week (as often before in Nottingham) where the father is out-of-work, and the mother and children are slaving away at lace for which from ½d. to 2½d. per dozen yards of from 6 to 12 breadths is paid.*

Similar evidence was given before the Select Committee on Home Work in June, 1907. "Children," said the same inspector, "are said to be employed at four years old. We have found them at six years of age employed several times, and a child of eight, a child of nine, and a child of twelve have been found earning several shillings a week."†

Numbers of children are engaged, too, in sorting hooks and eyes, in Birmingham. Both before the Inter-Departmental Committee in 1901, when one head teacher described the children as working all night, and again last year, evidence was given of children working for hours at this industry. The Chief Inspector for factories in Birmingham spoke of having found personally children of three, four, and five years of age at work.‡

It is difficult to investigate the number of children engaged in agricultural operations, the Parliamentary Return of 1899 puts the number at 6,115 §, but the Inter-Departmental Committee were of opinion that if hop-pickers and fruit pickers were included, the number would be much greater; their estimate was 50,000. The country correspondent of the Board of Trade gave a great deal of important evidence regarding the extent to which young children were employed. "During the spring, a number of children are kept at home gardening; and, in the summer, they are employed by farmers."‖ "Many very young children," writes a Cambridgeshire landowner, "have been employed in picking fruit, particularly strawberries, &c. Undoubtedly the work has had a bad effect upon the health, education, and moral character of the children engaged. First, as to health: Children leave their homes about 3.30 a.m. to pick strawberries in wet, as well as dry, weather; then return to school, with the result that many fall asleep, in front of their teachers, through exhaustion."* The evil effects on education and character to London children, engaged in hop-picking and fruit-picking can, perhaps, hardly be over-estimated. I have frequently talked to children in some of our poorer schools as to their life on the hopfields. The accommodation provided frequently appears to be of the scantiest description, and more often than not they are sent into the country in the care of friends and neighbours, and not in the company of their parents.

A point which has not always been noted, is the danger attached to certain agricultural employments, especially those involved in leading horses harnessed to hay carts. From time to time, local newspapers contain sad details of boys of eight or nine being crushed by waggons when engaged in this occupation. It is only fair to say that such cases are, fortunately, of rare occurrence. It should be added that one of the Board of Trade country correspondents, who gave evidence, described this work as "looking very dangerous."

A good deal of valuable information is available regarding the injury—physical and educational—which is inflicted on children who attend school full time, and are also engaged in hard industrial work. The investigation made by Dr. Thomas, the assistant medical officer of the London County Council, during 1905, showed distinctly how deleterious was the effect of this labour. If this investigation had dealt with a larger number of children, and had been available during the deliberations of the Inter-Departmental Committee seven years ago, it is not improbable that we might have seen child employment prohibited altogether. The facts obtained are of vital interest and importance. Dr. Thomas carefully examined 340 boys engaged at work in 14 boys' schools, representing an attendance of 3,864 children. He showed distinctly that in those working 20 hours or less, 50 per cent. showed fatigue signs, 34 per cent. anæmia, 28 severe nerve

* "Factory and Workshops Report for 1906," p. 229.

† "Home Work; Report of the Select Committee," 1908. (Cd. 218), p. 56. Wyman and Sons.

‡ "Home Work Report," p. 71.

§ "Children Working for Wages," p. 43.

‖ "Minutes of Evidence" (Mr. Smith, Southwich), p. 282. See also p. 278.

* "Minutes of Evidence" (Mr. H. Sharpe, D.L., C.C., Wisbech), p. 285.

signs, 15 per cent. deformities, and 11 per cent. heart signs. Of those working 20-30 hours, 81 per cent. showed fatigue signs, 47 per cent. anæmia, 44 per cent. nerve signs, 21 per cent. deformities. Of those working over 30 hours, 83 per cent. showed fatigue signs, 45 per cent. anæmia, 50 per cent. nerve signs, 22 per cent. deformities, and 20 per cent. severe heart signs.* Dr. Thomas also differentiated between the effect which employment had on boys engaged in different types of occupations. Thus, while the general effect on a total of 330 examined for this purpose showed 40 per cent. to be suffering from anæmia, 40 per cent. to have nerve signs, 17 per cent. deformities, and 16 per cent. heart disease, shop boys. who carry heavy weights, showed in 44 per cent. of cases nerve signs, 26 per cent. deformities, and 21 per cent. heart disease. Real suffering was found among lads employed in barbers' shops, 72 per cent. of whom were declared to be suffering from anæmia, 63 per cent. to have nerve signs, aud 27 per cent. heart disease.

Among the enquiries made by head-masters in 1901, one is especially worth quoting, as giving general evidence of the evil effects of employment. At Lillie-road School, Fulham,† 103 boys out of a roll of 476, or about 20 per cent., were returned as working for wages. Of this number 54 worked for more than 20 hours weekly ; 46 of these children were described as poor, fair, or weakly. Only 30 were stated to be normal, of good physique, or showing no evil effects. The remaining 27 were described as very fair. One boy had caught rheumatic fever through milk selling. He had had repeated colds through sitting in school with wet feet. Another boy had a bad illness caused by carrying heavy baskets. Another suffered with ear disease. Another boy had his arm broken in his work.

Educationally the effects are also bad. Of the 103 boys whose cases were so carefully investigated by this head teacher, 54 were described as being "dull" or "very dull," "back in their work," or as having been degraded a standard. Dr. Thomas also found, in the course of his 1905 enquiry, that out of the 330 boys carefully examined, 209 showed retardation in school work, 86 being one standard, 83 two standards, and 3 four standards behind that corresponding to their age.

Girls equally show the effects of over-work. In the same Report, the Medical Officer for Education gives some details of cases of overpressure discovered in girls' schools. Dr. Marion Hunter found that carrying heavy weights and minding babies are often the means of bringing about lateral curvature and flat-footedness. Quite recently 9 out of 23 girl wage-earners, seen in a South London school, were described by the head mistress as being very delicate, and their appearance bore ample testimony to this fact, though no scientific enquiry was possible.

Another important conclusion has been arrived at by the Council's medical officers in the course of investigation—that as a rule it is the children above the average in physique and exceptionally brilliant mentally who go to work. The evil effects are shown later, when the best capital of the nation has been squandered in premature wage-earning.

It will be asked, Are there no remedies for this undesirable state of things ? It has been shown that in regard to half-timers nothing except the raising of the age and the ultimate prohibition of child labour in factories can be of any avail. For children in unregulated industries much might be done by enforcing more stringently the provisions of the Employment of Children Act, 1903—an Act which was passed in consequence of the deplorable state of affairs revealed by the witnesses who gave evidence before the Inter-Departmental Committee in 1901. Power is given by this measure to local authorities to frame by-laws* prescribing the age below which employment is illegal, the hours between which employment is illegal, prohibiting absolutely, or permitting subject to conditions, the employment of children in any specified occupation. They may further make regulations prohibiting street trading,† subject to such conditions of sex and age, or the holding of a license to trade. They may also require street traders to wear badges, and determine the hours at which such employment shall be carried on. The Act also contains certain statutory provisions. No children may be employed between nine at night and six in the morning. A child under eleven must not engage in street trading. A child employed as a half-timer may not be employed in any other occupation. A child may not lift, carry or move heavy weights likely to cause injury, or engage in occupation likely to prove injurious. No child under ten

* "Report of the London County Council Medical Officer for Education," 1906, pp. 21, 22, 23, 24.

† "Minutes of Evidence," pp. 405-409.

* "Employment of Children's Act," Section I., Section III.

† "Employment of Children's Act," Section I., 43.

may be licensed for theatrical entertainments.*

It will be noticed that the statutory provision, as to hours, put an end to some of the worst cases of overwork, such as those of children who were employed, until recently, till 10 or 11, or midnight, in home work, in hawking, or in shops. But without the stiffening of by-laws, and without the energy and goodwill necessary to put such by-laws into operation, the Act is of little use. By-laws had been made up to the 25th of February of this year (1908)† by 79 local authorities, but of this number only 36, out of a possible 67, were county boroughs. Three counties (London, Middlesex, and Gloucestershire), and seven urban districts have also made regulations. In 34 instances these by-laws only deal with street trading. There seems a general disposition to regulate street trading in the first instance, possibly because its dangers are more apparent to the general mass of citizens, and possibly too, because of the objections raised by trade organisations to a system which secures further limitation of the supply of cheap labour to small shopkeepers. It is a matter for regret that only in two instances—Burnley and Hornsey—have local authorities definitely prohibited street trading by girls. In other cases they have weakened the bye-laws, and made them practically useless, by inserting a provision permitting street trading in the company of a parent or guardian. As one official of wide experience recently said, such a provision may lead to worse evils than those which it is sought to combat, for no girl should be allowed to trade in the streets under any conditions whatever. Certain local authorities, while not actually prohibiting street trading by girls, have refused to issue licenses, and it is satisfactory to note from information courteously furnished to me by the Town Clerks of these, and other boroughs, that no girls are trading in the streets at Banbury, Crewe, Eastbourne, Hove, Newport, Norwich and Stretford.

In London, Croydon, Eastbourne and Norwich great difficulties were experienced in securing effective by-laws. The late Home Secretary raised continual objections to the regulations proposed. This was especially the case with London, where an enquiry was held extending over several weeks, the purpose of hearing objections from employers and others interested in the matter. Practically no objections were raised, but the Commissioner, Mr. Chester Jones, refused to take this fact into consideration. In his report he says:—

"I have had very great difficulty in arriving at a conclusion as to what weight, if any, should be given to this apparent want of interest on the part of employers of child-labour on the question of the proposed restrictions. At first sight it would appear that these employers were indifferent as to whether the by-laws came into operation or not and that except on the part of newsagents and the barbers, the opposition to the by-laws was of a most faint-hearted description. But on further consideration, having regard to the fact that the lack of opposition may have been due to some cause of which I am not aware, such as want of funds or lack of organisation, and having regard to the well-known apathy of the people in London with respect to local matters, I have decided not to allow the abstention of the employers to weigh with me in the conclusions to which I have arrived."*

This most unfortunate decision, based apparently on no premises whatever, had the effect of considerably weakening the by-laws. The provisions limiting the hours of employment from 7 to 8.30 in the morning and from 5 to 7 in the evening were deleted. But even as the by-laws stand they do enable some of the worst cases of overwork to be dealt with. Firstly, all employment of children under 11 is prohibited. The hours of work are restricted in home industries to employment between 5 and 8 in the evening; work from 9 to 12 a.m. is only allowed on days when the school is not open. In other employments, children are allowed to work between 6 and 8 a.m., or between 5 and 8.30, provided that the limit of 3½ hours of employment is not passed. On days when the school is not open, 8 hours are permitted—an amount which must involve too great a physical strain. Sunday labour, between the hours of 7 and 1 p.m. (but for three hours only) is allowed. Barbers' shop work is permitted to boys over 12 years of age. This is a most undesirable provision in view of the evil physical effects produced by this occupation. It should be noted that Bath, Crewe, East Ham, Hull, and Stoke on Trent have raised the age for lather work to 13 years, while Banbury, Brighton, and Sheffield have prohibited it altogether. Work in small hand laundries, which are outside the jurisdiction of the Factory Acts, is forbidden. A mass of

* "Employment of Children's Act, 1903," Section II.

† "Return of Local Authorities which have made By-laws under the Employment of Children Act," No. 249. 1907. Corrected to Feb. 28th, 1908.)

* "Report on the London County Council By-laws under the Employment of Children's Act, 1905," p 6.

evidence given before the Inter-Departmental Committee had demonstrated the evil, moral, and physical effects on little girls engaged in this industry. As regards street trading, girls under 16 years may only hawk in the company of their parent or guardian. It is a great pity that total prohibition was not insisted upon. The working of this by-law will need careful watching. Certain societies have given undertakings to seek work for any girls displaced by the operations of the by-law.

Endeavours were made by the London County Council Education Committee to make regulations preventing all street trading by children of school age, but without success. The Home Office refused to raise the age for this occupation from 11 to 12, although it is lower in London than such large centres of population as Barrow, Bolton, Crewe, Eastbourne, East Ham, and Newcastle-on-Tyne. Street trading is, however, only permitted between 7 and 8 a.m. and between 5 and 8 for children trading alone, though on days when the school is not open, or during the summer months—April to October—they may work till 9 p.m. Between the ages of 14 and 16 they may trade between the hours of 6 a.m. and 9 p.m., provided it is not for more than 8 hours in any one day.

But despite the deficiencies in the by-laws, some distinct improvement is manifest. Recent enquiries have shown that there is a decided tendency to allow children to leave work by nine o'clock. The by-law designates 8.30 as the hour, and there will doubtless be little difficulty in enforcing this limitation. Twenty prosecutions for illegal employment of children were undertaken by the Public Control Committee of the London Council, between the 15th of October, 1907, and the 14th of January, 1908. The work has now been taken over by the Education Committee, and many thousands of handbills, giving the provisions of the Act, have been placed in the hands of parents, teachers, and employers. The effect of by-laws carefully enforced is favourably commented upon by local authorities which have had an opportunity of watching a year's working of their regulations. Two important results are noted by a local authority on the borders of London.

1. A reduction has taken place in the number of school children employed by tradesmen, as they have been replaced by boys who have left school and who work full time.

2. A reduction has taken place in the number of school children employed as house boys, as they have been replaced by girls who have left school and who work full time as domestic servants.

No remarks could illustrate better the true relation between child labour and unemployment. One further point remains to be dealt with. Is the labour of the child of vital necessity to the home? It is, of course, not possible to dogmatize absolutely on the matter, but it is worth while bringing to your notice some facts submitted by the Committee on Wage Earning Children to the Inter-Departmental Committee. Particulars were obtained of the incomes of 802 London families whose children were employed out of school hours. In only 143 instances were the earnings found to be under 20s. weekly; in 189 it ranged between 20s. and 25s.; in 154 between 25s. and 30s.; and 316 families were returned as having an income of 30s. and over. Similar results were obtained from Bradford, Leeds, Gateshead, Coventry, and Plymouth, typical towns in different parts of the country. Of 714 cases investigated more than half had an income of 30s. and over, while in 258 instances it was shown to be over 35s.* It will, therefore, I think, hardly be gainsaid that, while cases of individual hardship might ensue in the total prohibition of juvenile labour, the gain to the children physically and educationally, and the economic improvement possible through the opening of new avenues to adult employment, are factors of the most vital importance.

We are day by day endeavouring to improve the physique of the children in our elementary schools, by organising a complete system of medical inspection; even medical treatment in school clinics is now only a question of administration. We feed the necessitous, we endeavour to secure all possible means of healthful recreation such as organised games, play centres, happy evenings and guilds of play. We are endeavouring to develop various methods of industrial and technical training for the children on the point of leaving school. Of what use, however, are all these efforts, if, during the most critical age of a child's development, we allow him to be handicapped for the battle of life by overstrain and the burden of hard manual work? It is earnestly to be hoped that a broader and a wiser view of our responsibilities to the child life of the nation may be realised in the near future, and that we shall refuse to exploit that most valuable of all national assets—the mental and physical powers of our boys and girls.

* "Minutes of Evidence," pp. 374-379.

KEROSENE SHALE.

Kerosene shale has been known in New South Wales for upwards of half a century, but probably the total output to date does not exceed 1,500,000 tons. Deposits have been proved in the north at Wallahadah, about 170 miles from Sydney; at Capertic, about 110 miles west of the same city, and at Mittagong, about 75 miles to the south-west of it. But to extract the crude oil, to refine it, and put the manufactured product on the market, means expensive plant, and many of the deposits would not repay the expenditure. There is again the difficulty of transport, either for raw or manufactured products, for few of the known deposits are near a rail or waterway. The kerosene shale varies in quality through a very wide range, the finest yielding up to 150 gallons of crude oil per ton, the volatile hydrocarbons in such a sample equalling 89·59 per cent., and the residual ash only about 4·98. In poorer qualities, the ash increases as the hydrocarbons decrease. The light grade of shale will produce from 17,000 to 18,000 cubic feet of gas, and thus takes front rank as a gas producing mineral. The poorer qualities are most economically adapted for the production of crude mineral oils, by retorting methods, and these again are treated to produce marketable commodities, such as kerosene, for lighting purposes, all classes of machinery and lubricating oils, mineral tallow, axle and other greases, naphtha, benzine, and solid paraffin. Most of the deposits exist in the upper coal measures, and are easily worked by ordinary sinking and driving.

The largest and most important deposit at present known in New South Wales is that in the Capertic and Wolgan Valley district, and here it is said 20,000,000 tons have already been proved. The shale deposit varies from one to five feet in thickness, and at its edges is found to pass into either bituminous or splint coal, or into an earthy carbonaceous shale. At Hartley, between Wallerarwang and Penrith, the seams of shale were found to extend for some distance on both sides of the valley, and it was generally supposed that denudation carried away the central portion of the deposit, but prospecting operations below the floor of the valley disclosed the existence of further deposits of similar shale, evidently thrown down by a trough fault. The vastness of the volcanic disturbances in this district can be imagined by the fact that the bed of Kanimbla Valley is fully 3,000 feet below the level of Mount Victoria, the highest point of the Blue Mountain ranges, and it is on the northern side of Mount Victoria that the Capertic Valley lies and on the southern the Hartley. A line of railway recently constructed will open up a new area. Here the scheme appears to be to mine the shale, keeping the higher grades, or roughly all mineral yielding over 100 gallons of crude oil per ton, for sale to gas-making companies and retailing the lower grades for the production of mineral oils.

Although, as far as is at present known, the Capertic and Wolgan deposits are the richest in New South Wales, it will probably be found that many other places will yield a handsome profit if worked. There are many known localities where payable shale deposits exist, but these deposits could not be satisfactorily worked from a financial point of view if complete refining plants had to be erected for each one. The formation, occurrence, and magnitude of New South Wales shale deposits are recognised as something quite different from anything previously known, and probably the Commonwealth Government will impose a duty that will effectually prevent the importation of American and Russian oils. In that case the local consumption will be ample to absorb all that can be produced from the shale deposits of New South Wales. As many capitalists in this country are already interested in Scotch or Colonial shale properties, it will be interesting to watch how the industry developes now that it has been fairly launched upon the only scale that can ensure economy in cost of production, and a satisfactory financial result. It may be that some of the deposits, more easy of access, nearer a rail or waterway, and of less magnitude, will be established as independent mines when once the public realises the great dormant wealth that awaits utilisation.

THE FRENCH WINE CROP OF 1907.

In former times, the importance of the French wine yield and the area planted in vines could only be ascertained by estimation, while the figures now available for 1907 rest upon declarations made by landed proprietors under the law of June 29, 1907. Under this law the area planted in vines, the crop of grapes harvested, and the amount of wine produced, are declared and verified according to a system fully set forth in the law. According to the "Bulletin de Statistique et de Legislation Comparée," issued by the French Ministry of Finance, the quantity of wine produced in 1907, as thus ascertatned, reached the enormous total of 1,453,546,006 gallons, as compared with 1,145,739,144 gallons in 1906, an increase of 309,807,862 gallons, and an increase of 380,360,000 gallons over the last decennial average. The extent of French vineyards in 1907 was 4,075,134 acres, or 120,364 acres less than the preceding year. It is stated that at the end of the eighteenth century the area of the French vineyards was estimated at 3,821,752 acres, and in 1851 the area had reached the figure of 5,386,852 acres. Compared with the yaar 1906, thirty-five Departments showed increases in the wine yield, the most marked being in the case of the four Departments of Herault, Aude, Pyrénées Orientales, and Gard. The Departments showing the greatest falling off in the wine yield of 1907 as compared with 1906 were the following:—Indre et Loire, Loire et Cher, Maine et Loire, Vienne, and the Loire Inférieure. Based upon the prices realised by the growers, the value of the crop of 1907 reached the sum of £44,692,000. In this total the wines classed as "superior" stand for £3,716,000, corresponding to a quantity of 24,906,000 gallons, while

the sum of £40,976,000 was realised for the enormous quantity of 1,429,340,000 gallons of "ordinary" wines. The French cider yield is established at 73,920,000 gallons, as compared with 490,622,000 gallons in 1906. The cider crop is below the average of the last ten years by 285,472,000 gallons. According to the "Bulletin de Statique," "the recent crisis in the French wine trade seems not to have been due to a phenomenon of over-production. Statistics show that at the time of the last harvest the stocks of wine on hand did not exceed 182,512,000 gallons, of which 51,898,000 gallons were in the Gironde Department (Bordeaux). This is a very low figure if the total annual crop be compared therewith, and if it is considered that it includes all the high-class wines which are seldom delivered until they have matured in the producers' hands. It may be said that there remains no unsold wine, properly speaking, and that France does not produce, in reality, more wine than she can utilise either or home consumption or exportation."

WHEAT-GROWING IN BRAZIL.

The State of Rio Grande do Sul, the southernmost State of the Brazilian Republic, and the one therefore with the coldest climate, has long been pointed to by Brazilian statesmen as a possible granary for Brazil. It has been thought that modern and scientific culture of wheat in the State would do much towards removing Brazil from its present necessity of importing all its breadstuffs, and there has been a strong movement from time to time towards fixing a higher duty upon foreign wheat for the protection of the Brazilian product. In line with these ideas and in response to the demand of capital for actual practical information as to the possibilities of wheat-growing in Brazil, an organisation was formed in Rio Grande do Sul, and a wheat-growing expert from Germany was brought over to conduct the experiments. According to the United States Consul-General at Rio de Janeiro, this expert has been at work for the past two seasons, and in the course of his work has gone over the possible wheat-bearing area of the State very thoroughly. At first he examined the country along the railway from the city of Rio Grande do Sul to Bagé, a distance of about 150 miles. The country in the vicinity of Porto Novo and Pelotas, cities of considerable importance and a district from which much was expected, was found to be entirely unsuited to wheat-growing. Further in the interior better results were obtained, and the country about the rivers of Candiota, Jaguarao, Jaguarao-Chico, and the Negro was found to be capable of producing very fair grain. In the course of the work, experiments were conducted as far north as Cruz Alta and as far south as Jaguarao, and to the west as far as Uruguayana. The territory which the investigator found most suitable to wheat-growing was that of Uruguaya and Quarahy, a comparatively small area in the extreme western portion of the State in a wedge-shaped district extending between Paraguay and Uruguay. Similar land suitable for the grain was also found extending along the southern border of the State, but the entire area was limited. Along the southern border of the State, in the district mentioned, the State purchased a number of sites for extensive experiments, the work being handicapped by the extremely high price placed upon the land by the proprietors as soon as the possibility of wheat-growing became known. On the State land seven varieties of wheat were tried, those common to Northern Europe, two varieties common in Italy, a new variety of Italian wheat, and the variety of wheat heretofore grown for various purposes in the State. As a result of the first year's work, it was shown that the varieties of wheat common to Northern Europe were well suited to growth in Brazil. The two Italian varieties, barletta and rieti, gave fair results. The native wheat also made good returns, and a new variety of Italian wheat, the fucense, gave indications that it would probably be easily acclimatised. During the last season experiments were continued with those varieties of the wheat which had given the better results during the first season. The season was exceptionally dry, and the experimenter considered that the results showed the probable production of about 19 bushels to the acre in an ordinary year. Modern implements, especially drills, are an absolute necessity if the crops are to be relied upon, and it is certain that the grain cannot be grown generally by the people without a good deal of education on practical agricultural lines.

TRANSFORMING OLD FIREARMS IN BELGIUM.

Owing to the many, and at times radical, changes that have taken place in the equipment of the armed forces of the leading nations of the world, large quantities of war materials, hardly the worse for wear, but become obsolete, must from time to time be discarded as unserviceable and disposed of, as a rule, at a decided pecuniary loss. This fact is particularly noticeable in the case of small firearms, as few implements of war have been more largely influenced by inventive ingenuity than the military rifle. The purchase of these discarded weapons, usually sold at public auction, their subsequent transformation and eventual disposition, form an important element of the Belgian firearm industry, for which the district of Liège is so well known. The American Consul at Liège says that it is generally supposed that none but new firearms, the product for the most part of the larger factories, are shipped from Liège, but a visit to one of the several transformation workshops affords convincing evidence of the fact that the export trade in firearms in that district is far from being exclusively confined to the newly made article. Among the well known makes of firearms already transformed, or undergoing transformation at the hands of the Liège gunsmiths, may

be mentioned several thousand rifles discarded by the Roumanian Government, nearly the same quantity of Gras rifles superseded in France by the Lebel, as well as a number of Comblain and Albini rifles, formerly used, and to a limited extent still used, by the Belgian civil guards. All of these arms of the single barrel type are transformed into the old-fashioned flintlock and percussion cap guns. In order to effect the change, the barrel, together with the breech mechanism, has to be removed, and is replaced by a muzzle-loading barrel, the lever is discarded, the wooden stock only remaining intact. The elongated cartridge cannot, of course, be used in these converted guns, which must return to the old time leaden bullet. In a word, these weapons are antedated, so to speak, some three or four score years, returning to the type of small arm used by Napoleon's troops. These transformed weapons, like other kinds of merchandise, have their current prices subject to the fluctuations of the market. At present prices range from about three shillings to eight shillings. The old Beaumont gun of the Dutch army is quoted at four shillings, while its original cost when new was about two pounds ten shillings. The Albini, a first-class arm and in good condition, sells at three shillings and ninepence. Out of some eight thousand gunsmiths who ply their trade in their own homes, a large proportion are engaged in producing antiquities, so to speak, as fully fifty per cent. of these transformed guns that are exported from Liège are flintlock pieces. A large profit in the business is also derived from making use of the undamaged parts of these second-hand guns, parts that are usually in a condition to be profitably utilised, and substituting in their places parts of a decidedly inferior grade. In many cases, among the discarded arms purchased are to be found excellent and serviceable repeating rifles, such as the Austrian Männlicher and the German Mauser, quoted at about twenty-one shillings and thirty-two shillings respectively. These arms are sold, as a rule, to the Governments of certain remote countries classed as uncivilised, and are disposed of without any modification. With regard to the German rifle, it may be mentioned that the German military authorities require the payment of ten shillings on each rifle purchased as a guarantee that the arm will not be sold to savage tribes nor to irregularly organised troops, this amount being refunded on the presentation of a voucher showing that the arms were not sold to unauthorised persons. These Austrian and German rifles, however, are classed as choice grades of arms, and the Sultan of Morocco, for instance, has not purchased an article of this class, although this potentate has on several occasions made rather important purchases of second-hand arms in Liège. Not long ago he bought some 40,000 Gras rifles at prices ranging from seven shillings and sixpence to eight shillings and sixpence. He has also purchased a few mitrailleuses discarded by some of the armies of Europe, and an entire set of military tents that had been used by the staff of the Belgian army during the annual manœuvres. Regarding the smuggling of arms and their sale to unauthorised persons, it is, of course, difficult to get at anything like reliable data, although it is well known that this contraband trade is extensively carried on.

CHINESE VITICULTURE.

Apart from being the centre of fruit culture in China, the province of Shantung produces large quantities of fine grapes, and promises soon to become a very important wine-making district. In the neighbourhood of Tsingtan, mainly on the southern slopes of the Laushan Mountains, many grapes are grown for the fruit only. Large quantities are now sent to Shanghai and other places annually, a variety closely resembling the Californian "tokay" predominating. White grapes are also grown, a sort of "sweetwater," and a kind called "marcobrunner" being the most common, but blue and black grapes are not found. Apparently no attempt to produce wine has been made here, but in North-Eastern Shantung, the industry has made some progress, according to the American Vice-Consul of Tsingtan. On the hills surrounding that city are many terraced vineyards, and an extensive wine-making establishment has been in operation for years. It is stated that white wines and red wines, and champagnes of many varieties are made, but none of the products have yet been placed on the market. Concerning the wine-making establishment at Chefoo, a wealthy Chinaman, about ten years ago, conceived the idea of cultivating grapes in China for the purpose of an extensive wine trade. Land was bought on the hills near Chefoo and planted with varieties of grapes from all wine-producing countries, under the direction of a European expert, who is still in charge. More land is constantly being acquired in the immediate vicinity, and planted as soon as bought, but the price of suitable territory has gone up considerably. Phylloxera is stated to have attacked some of the varieties, but never to a disastrous extent, most of the vines appearing to be immune. Each autumn the entire crop is taken to the wine-making establishment on the outskirts of the town, and after production the wine is stored in large casks, constructed in sections in Austria, shipped to Chefoo, and set up in the cellars. Every barrel is plainly marked with the variety of wine it contains, together with the year of its production. The cellars, started four years ago, took two years to complete, and are built below the level of the sea. They are lined with concrete, as it was found that they were otherwise being constantly flooded. There is now a large supply of wine on hand, but it is stated that the first sales are not to be made until the end of 1908 or in 1909. The market is to be exclusively the Chinese coast, but the leaders of the enterprise do not say what the prices will be, but considering the amount of the investment, a low price is not to be expected.

HOME INDUSTRIES.

The Atlantic Service.—Sir William White, who has just returned from a round trip on the *Mauritania*, recently gave it as his opinion that, given good weather conditions, she will presently do the run between Daunt's Rock and Sandy Hook at an average speed of 25 knots. No doubt even that great speed will be exceeded by other boats with more powerful engines as time goes on, and meantime the White Star Line have decided to build two steamers for their Southampton-New York service which shall be larger than any afloat. These monsters, it is interesting to note, will be propelled by a combination of reciprocating and turbine engines, and their speed will not be less than 21 knots. It is not as yet definitely known when the work of construction will be begun, but it may be taken that it will be shortly.

A Silk Exhibition.—The silk industry of the United Kingdom has recently shown signs of revival, and experts are of the opinion that much of the lost ground may be regained. With the object of assisting the revival, the Council of the Silk Association of Great Britain and Ireland have decided to hold an Exhibition of British and Irish silks in London in the spring of 1809. The shape which the display will take has not yet been definitely decided, but it will be on similar lines to the recent exhibition of British lace. The Council have been considering cost, and a strong appeal will be made to all members of the Association to support the Exhibition. The officials still complain of unfair conditions attached to the silk trade in the terms of the Carriers' Act, and efforts are being made to induce the Board of Trade to introduce reforms to remove a grievance which has handicapped the silk industry for many years.

Wool Supplies.—Official figures to hand, from Australia, show how wide of the mark leading Australian newspapers were last autumn with their forecasts of big reductions in the number of sheep depastured in the various States, and especially New South Wales. The official figures for Queensland show a big increase for the year, and a rise in the number of sheep depastured in that State since the close of the big drought, in 1902, from 6,000,000 to nearly 17,000,000. In Victoria there was, on March 31st, 1907, 12,937,440 sheep, on the same date this year the number was 14,146,734. It is calculated that the owners who realised their clips in the Colonial markets last year, obtained not less than £5 per bale more than those who shipped to London, and instances are given where wools purchased by speculators, at Adelaide, have lost up to £7 per bale. This year the men who sold in the colonies are pretty sure to ship to London, and growers are being advised not to hurry with shearing and to get their wool to London as late in the season as possible.

Wireless Telegraphy.—It was hoped that when the Marconi Wireless Telegraph Company applied to the public for additional capital data would be given from which it would be possible to gather the prospects of wireless telegraphy for general business purposes, as also the position with respect to the Transatlantic service. But this data is not as yet available. For communication between ships at sea and between ships and shore stations its practical success is assured, but the Transatlantic service is in an earlier stage of development. The service between Clifden and Glace Bay was opened on the 17th October last with a limited service for press messages. On February 3rd this service was extended to ordinary messages between London and Montreal the transatlantic rates proper being 2½d. per word for press and 5d. for ordinary messages. To these rates are added the charge for transmission over the land lines in America which necessarily vary according to the distance of the points of destination from Glace Bay. The prospectus states that up to the present the Transatlantic wireless telegraph service has been conducted at speeds varying up to 24 words a minute, but that with a comparatively inexpensive modification of certain parts of the existing apparatus an average speed of at least 30 words a minute should be obtained, and it is expected that it will be possible to send and receive simultaneously at this speed, so that 60 words a minute may be dealt with. The maritime service is said to be progressing satisfactorily, and the number of words transmitted and received increased from 657,785 in 1905 to 1,834,540 last year. There seems little ground for the fear that wireless telegraphy will be a serious menace to the cable companies. It will probably be found that whatever the developments in wireless telegraphy there will be work for every available medium of telegraphic communication between distant countries once the cost of the service is brought within the means of ordinary pockets.

Workmen's Compensation and Insurance Companies.—The balance-sheets of insurance companies for 1907 show the very considerable increase of premium income derived from accident insurance of all kinds. The Workmen's Compensation Act of 1906 brought an immense amount of new business to leading insurance companies, and many offices whose operations were formerly confined to fire and life insurance opened a new department for all classes of accident business. Few companies now restrict their operations either to fire or to accident insurance, but many that have made a new departure in undertaking workmen's compensation insurance have confined themselves to underwriting the smaller risks, and such as arise out of comparatively non-hazardous occupations. It seems to be generally agreed that the insurance of domestic servants has not proved as profitable as was generally expected.

Thrift and Credit Banks.—Lord Wenlock's Bill, intended to provide for the establishment of thrift and credit banks, has been very sympathetically

received, and in principle commands general support. It is hardly likely to become law this year, but it may be hoped that it will not be long before Parliament passes a measure of the kind. In the final report of the Royal Commission on congestion in Ireland, just issued, reference is made to agricultural banks and the good work that is being done in Ireland by co-operative credit associations, commonly called Raiffeisen banks. What Raiffeisen did was to join together a number of small farmers, whose individual credit was bad, and by their union create a greater security than the individual farmers could offer. They borrow on their joint and several liability a large sum of money, at a low rate of interest, which they lend in varying sums to such of their members as require a loan. All the affairs of the bank are managed by a committee elected by the members. No loan is made except to a member who can be trusted to employ it reproductively, and who is obliged to produce one or two sureties. Their funds are obtained on loan from joint stock banks and from local depositors, and in the poorer districts the Irish Board has lent to individual societies amounts varying from £30 to £200, upon which the bank pays interest at the rate of from 2½ to 3½ per cent. These small loans serve as a nucleus around which other sums gather by degrees until sufficient capital is acquired. The Raiffeisen banks thus aided issue numerous small loans to their members—the very poor—who could not obtain credit elsewhere. The profit to individual borrowers is generally very considerable, and, so far, practically no losses have been incurred by the banks—indeed, in nearly every case a small profit has been made and carried to the reserve fund. At 31st March, 1907, there were in the congested districts in Ireland 65 banks in working order, and 32 which had not commenced operations, or which had been closed. There were 5,756 members, to whom 4,169 loans had been made, amounting to £17,300. Since then there has been a large increase, there being now 273 credit societies, the usefulness of which, according to the Irish Agricultural Organisation Association, would be trebled by Lord Wenlock's measure.

GENERAL NOTES.

The Cotton Trade in the Southern States of America.—In his report on the trade of the district of Savanah (Annual Series, No. 3986), Mr. Consul Donnelly gives some interesting figures as to the Southern mills consumption last season. There was an unprecedented demand for cotton. In spite of the scarcity of labour consumption showed a gain of 54,000 bales. In "active" mills, the number of spindles increased 791,965, and "new, not completed," 640,978. The largest increases were in Georgia and North Carolina, especially the last-named State, which leads as the largest consumer of cotton of any State of the South. The money value of the American cotton crop of last year was the largest ever recorded, 716,000,000 dols., or 88,000,000 dols. more than the great crop of 1904-5, and 75,000,000 dols. more than that of 1905-6. In 1904-5 the crop gave 13,565,885 bales, as against 13,510,982 last year, but the money value of the 1904-5 crop was only 628,195,359 dols., as against 716,352,265 dols. for that of last season.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 15. Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. G. Forrest, "Journey on the Upper Salwin."

Victoria Institute, 8, Adelphi-terrace, W.C., 4 p.m. Annual Meeting.

Tuesday, June 16...Asiatic, 22, Albemarle-street, W., 4 p.m. Dr. Gaster, "The Newly-Discovered Samaritan Book of Joshua."

Statistical, 9, Adelphi-terrace, W.C., 4½ p.m. Annual Meeting. Mr. A. L. Bowley, "The Improvement of Official Statistics."

Zoological, 3, Hanover-square, W., 8½ p.m.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Address by Viscount Milner.

Wednesday, June 17...Meteorological, 70, Victoria-street, S.W., 4½ p.m. 1. Mr. R. H. Hooker, "An Elementary Explanation of Correlation: Illustrated by Rainfall and Depth of Water in a Well." 2. Mr. Lawrence Gibbs, "The Hong Kong Typhoon, September 18th, 1906."

Geological, Burlington-house, W., 8 p.m.

Royal Microscopical, 20, Hanover-square, W., 8 p.m. 1. Messrs. E. Heron-Allen and A. Earland, "Cycloloculinæ, a new Generic Type of the Foraminifera." 2. Mr. G. W. Gordon, "Illuminating Apparatus for the Microscope." 3. Messrs. Gordon and H. Fletcher Moulton will exhibit a New Lens for High Power Microscopes. 4. Exhibition of Micro-Slides by Mr. A. Flatters, "The Development of the Chick."

British Archæological Association, 32, Sackville-street, W., 8 p.m.

Thursday, June 18...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m.

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. W. A. Bone and H. F. Coward, "The Thermal Decomposition of Hydro-Carbons. Part I. (Methane, Ethane, Ethylene and Acetylene.)" 2. Mr. W. A. Tilden, "The Rusting of Iron." 3. Messrs. E. Wedekind and S. J. Lewis, "Studies on Elementary Zirconium." 4. Mr. H. Finnemore, (*a*) "The Constituents of Canadian Hemp. Part I. Apocynin"; (*b*) "A new Synthesis of Apocynin." 5. Mr. F. D. Chattaway, "The Constitution of the Diazonium Perbromides." 6. Messrs. C. Dorée and J. A. Gardner, "Cholestenone." 7. Mr. A. E. Hill, "A New Form of Potash Bulb." 8. Messrs. B. H. Buttle and J. T. Hewitt, "Solubility of Silver Chloride in Mercuric Nitrate Solutions."

Optical, 20, Hanover-square, W., 8 p.m. Mr. V. H. Mackinney, "The Optics of Light Projection."

Historical, Lecture-hall, Field-court, Gray's-inn, W.C., 5 p.m.

Numismatic, 22, Albemarle-street, W., 6½ p.m. Annual Meeting.

Friday, June 19...African, Trocadero Restaurant, Piccadilly, W., 7½ p.m. Colonel A. E. G. Watherston, "The Northern Territories of the Gold Coast."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Journal of the Royal Society of Arts

No. 2,900. VOL. LVI.

FRIDAY, JUNE 19, 1908.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal* in accordance with Sec. 40 of the Society's By-laws :—

TREASURERS' STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING MAY 30TH, 1908.

Dr.

	£ s. d.	£ s. d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1907		2,656 11 10
,, Subscriptions	5,569 4 0	
,, Life compositions	456 15 0	
		6,025 19 0
,, Dividends and Interest		621 1 0
,, Ground Rents		669 10 3
,, Examination Fees		3,410 4 10
,, Conversazione, 1907 (sale of tickets)		100 10 0
,, Advertisements		618 15 0
,, Sales, &c. :—		
"Cantor" Lectures	32 5 7	
Examination Programmes	44 5 8	
Fees for use of meeting-rooms	42 0 0	
Journal	104 5 7	
		222 16 10
,, Donation to Examination Prize Fund :— Clothworkers' Company		30 0 0
,, Committee on Leather for Book-binding :— Sale of Reports		26 8 5
		£14,381 17 2

Cr.

	£ s. d.	£ s. d.
By House :—		
Rent, Rates, and Taxes	829 6 0	
Insurance, Gas, Coal, House expenses and charges incidental to meetings	354 10 9	
Repairs and Alterations	508 15 6	
		1,692 12 3
,, Office :—		
Salaries and wages	2,302 6 7	
Stationery, Office Printing and Lithography	437 16 2	
Advertising	75 5 0	
Postage Stamps, Messengers' Fares, and Parcels	299 13 4	
		3,115 1 1
,, Library, Bookbinding, &c.		98 0 5
,, Conversazione (1907)		511 11 6
,, *Journal*, including Printing and Publishing		2,265 17 2
,, Advertisements (Agents and Printing)		298 9 3
,, Examinations		3,475 14 10
,, Medals :—		
Albert	20 9 0	
Society's	29 13 5	
		50 2 5
,, "Owen Jones" Prizes		18 19 0
,, Drawing Society's Prizes		25 19 3
,, North London Exhibition Prizes		14 14 0
,, "Mulready" Trust		1 0 0
,, "Aldred" Trust		10 0 0
,, Juvenile Lectures		20 0 0
,, "Howard" Lectures		35 0 0
,, "Cantor" Lectures		184 11 0
,, "Shaw" Lectures		57 0 0
,, Sections :—		
Applied Art	60 0 0	
Colonial	48 7 4	
Indian	69 10 7	
		177 17 11
,, Committees (General Expenses)		20 14 1
		12,073 4 2
,, Cash in hands of Messrs. Coutts and Co., May 30th, 1908		2,308 13 0
		£14,381 17 2

Liabilities.

	£ s. d.	£ s. d.
To Sundry Creditors	698 9 9	
,, Examiners' Fees	1,124 13 6	
,, Examination Prizes and Medals	215 0 0	
,, Sections :—Applied Art, Colonial, and Indian	150 0 0	
,, Accumulations under Trusts	409 17 1	
		2,598 0 4
,, Excess of assets over liabilities		24,897 7 0
		£27,495 7 4

Assets.

	Amount of Stock, &c. £ s. d.	Worth on 30th May, 1908. £ s. d.	£ s. d.
By Society's Accumulated Funds invested as follows:			
Newcastle-on-Tyne $3\frac{1}{2}$ per cent. stock	3,000 0 0	3,000 0 0	
Canada 4 per Cent. Stock	500 0 0	502 10 0	
South Australia 4 per Cent. Stock	500 0 0	515 0 0	
N.S. Wales $3\frac{1}{2}$ per Cent. Stock	530 10 1	533 3 0	
N.S. Wales 4 per Cent. Stock	500 0 0	545 0 0	
G. Indian Pen. Ry. 4 per Cent. Debenture Stock	217 0 0	245 4 2	
Queensland 4 per Cent. Bonds	1,500 0 0	1,560 0 0	
Natal 4 per Cent. Stock	500 0 0	530 0 0	
Ground Rents (amount invested)	10,496 2 9	10,496 2 9	
Metropolitan Water Board B. Stock	321 15 9	300 16 9	
New River Co. shares	6 0 0	6 0 0	
National War Loan	3,134 8 3	3,142 4 8	
	21,205 16 10		21,376 1 4
,, Subscriptions of the year uncollected		745 10 0	
,, Arrears, estimated as recoverable		346 0 0	
			1,091 10 0
,, Property of the Society (Books, Pictures, &c.)			2,000 0 0
,, Advertisements due			319 3 0
,, Cash in hands of Messrs. Coutts and Co., 30th May, 1908			2,308 13 0
,, Do. on Deposit (against interest on Trusts)			400 0 0
			£27,495 7 4

Funds held in Trust by the Society.

Dr. Swiney's Bequest	£4,477 10 0	Ground-rents, chargeable with a sum of £200 once in five years.
"John Stock" Trust	100 0 0	Consols, chargeable with the Award of a Medal.
"Benjamin Shaw" Trust for Industrial Hygiene	133 6 8	,, ,, ,, of Interest as a Money Prize.
North London Exhibition Trust	192 2 1	,, ,, ,, ,,
"Fothergill" Trust	388 1 4	,, ,, ,, of a Medal.
J. Murray and others, in aid of a Building Fund	75 14 4	,, £54 18s. od. and National War Loan £20 16s. 4d.
Subscriptions to an Endowment Fund	562 2 2	,,
Dr. Aldred's Bequest	220 2 3	,, chargeable with the Award of a Prize.
Thomas Howard's Bequest	571 0 0	Metropolitan Railway $3\frac{1}{2}$ per Cent. Preference Stock, chargeable with the Award of a Prize for an Essay.
Dr. Cantor's Bequest	648 19 7	Bombay and Baroda Railway Guaranteed 3 per cent. Stock } Interest applied to the Cantor Lectures.
	3,273 16 6	India 3 per cent. Stock
	2,695 11 3	Ground-rents
"Owen Jones" Memorial Trust	423 0 0	Canada 4 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
"Mulready" Trust	105 16 0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
Alfred Davis's Bequest	1,953 0 0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
Amount to cover accumulated Interest on Trust Funds	400 0 0	On Deposit with Messrs. Coutts and Co.
	£16,220 2	

TOTAL OF INVESTMENTS, &c. (FACE VALUE), STANDING IN THE NAME OF THE SOCIETY (INCLUDING SOCIETY'S ACCUMULATED FUNDS AND TRUSTS AS ABOVE).

Ground Rents (amount of cash invested)	£17,669	4	0
Consols	1,650	12	6
Metropolitan Railway $3\frac{1}{2}$ per Cent. Preference Stock	571	0	0
Bombay and Baroda Railway Guaranteed 3 per cent. Stock	648	19	7
India 3 per cent. Stock	3,273	16	6
Canada 4 per Cent. Stock	923	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales $3\frac{1}{2}$ per Cent. Stock	530	10	1
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Bonds	1,500	0	0
Natal, 4 per Cent. Stock	500	0	0
Newcastle-on-Tyne $3\frac{1}{2}$ per cent. Stock	3,000	0	0
Metropolitan Water Board B. Stock	321	15	9
New River Company Shares	6	0	0
National War Loan	3,155	4	7
Cash on Deposit with Messrs. Coutts and Co.	400	0	0

Society's Accumulated Funds	21,205	16	10	£37,425	19	0
Trust Funds held by Society	16,220	2	2			

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

GEORGE BIRDWOOD, JOHN M. THOMSON, } *Treasurers.*

H. T. WOOD, *Secretary.* KNOX, CROPPER & Co., *Auditors.*

Society's House, Adelphi, 17th June, 1908.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Fifty-fourth Annual General Meeting for the purpose of receiving the Council's Report and Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held in accordance with the By-laws on Wednesday, 24th June, at 4 p.m.

(By Order of the Council),

HENRY TRUEMAN WOOD,
Secretary.

EXAMINATIONS.

The results of the Advanced Examinations (Stage III.) have been published, and copies have been sent to all Centres for distribution to Candidates.

The results of the Intermediate Examinations (Stage II.) will be published during July, and those of the Elementary (Stage I.) early in August.

ALBERT MEDAL.

The Council of the Society, with the approval of His Royal Highness the President, have awarded the Albert Medal of the Society for the current year to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S., "For his investigations into the liquefaction of gases and the properties of matter at low temperatures, investigations which have resulted in the production of the lowest temperatures yet reached, the use of vacuum vessels for thermal isolation, and the application of cooled charcoal to the separation of gaseous mixtures and to the production of high vacua."

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Thursday evening, July 2nd, from 9 to 12 p.m.

The Reception, by Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by

the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert, under the direction of Mr. Harry Tipper, will be given in the Reptilia Gallery from 9.15 till 10.15 p.m., and from 10.30 till 11.30 p.m.

A Gramophone and Auxetophone Concert, under the direction of the Gramophone Company, will be given at the Western End of the Bird Gallery at intervals from 9.15 p.m.

The following portions of the Museum will be open :—

The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions; protective resemblance, &c. Also models of the Tsetse-Fly, the Malaria Mosquito, and the life history of the Malaria Parasite. A splendid specimen of the Sea Elephant has recently been placed on exhibition here.

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrated Animals of the British Isles.

The Gallery containing the Reptiles, including the three gigantic fossil forms *Diplodocus* and *Triceratops* from Wyoming, U.S.A., and *Iguanodon* from Bernissart, Belgium.

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Visitors travelling by District Railway (or other underground railways in connection) will be allowed free use of the Company's Subway, which leads from the South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. These cards are now in course of issue. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the day of the conversazione. On that date the price will be 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

A programme of the arrangements for the evening will be published in due course.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, May 21; SIR WILLIAM LEE-WARNER, K.C.S.I., in the chair.

The CHAIRMAN said that neither the subject of the paper nor the identity of the author required any words from himself. The members would know the Society was going through the various provinces of India, and, of course, the province which in the opinion of most people was the foremost of all must have its turn. He was glad that the subject had been entrusted to one of those distinguished lieutenant-governors who had ruled over the provinces. Sir James La Touche followed a remarkable sequence of able men of the Civil Service—Sir Alfred Lyall, Sir Auckland Colvin, Sir Charles Crosthwaite, and Sir Antony MacDonnell.

The paper read was—

THE UNITED PROVINCES OF AGRA AND OUDH.

By SIR JAMES DIGGES LA TOUCHE, K.C.S.I.

INTRODUCTORY.

The territory of which I am about to speak has, since March, 1902, been officially known as the United Provinces of Agra and Oudh. It is identical with the territory previously designated as the North-Western Provinces and Oudh, and the name of the United Provinces recalls the fact that, in 1877, the office of Lieutenant-Governor of the North-Western Provinces was amalgamated with that of the Chief Commissioner of Oudh, and that from that date there has been a single local govern-

ment. Within this territory are two States which are not directly under British rule: Rampur, which is held by a descendant of the Rohilla Afghans, who founded a principality in Rohilkhand in the early part of the eighteenth century, and Tehri Garhwal, a Rajput State in the Himalaya Mountains. The rest of the Province is British territory, and is divided into forty-seven local charges or districts. The population amounts to 48 millions, spread over 107,000 square miles, with a density of 445 to the square mile.

Establishment of British Rule in the Provinces.

The whole of this region, known to the Mohammedans as Hindustan, was gradually brought under British rule. It was from Bengal that the British power advanced to supremacy over the continent, and after the battle of Buxar, in which, in September, 1764, the Vizir of Oudh was defeated, the English were drawn into connexion with Upper India. The first portion acquired was the Province of Benares, obtained by treaty from the Nawab of Oudh in 1775, in the time of Warren Hastings. This included five of the present districts. Again, in 1801, the Nawab of Oudh ceded 15 districts to pay for the expense of a subsidiary force. These districts lay in a semi-circle round the Oudh territory from Basti and Gorakhpur in the east, to the Rohilkhand districts in the west. The victories of Lord Lake over the Mahrattas in 1803 added the Delhi districts, Agra, Muttra, and the whole of what is now the Meerut Division, up to Dehra Dun. Dehra Dun and the Himalayan districts of Garhwal, Almora, and Naini Tal were ceded by the Nepalese after the war of 1815. Since that war the policy of the rulers of Nepal has been one of complete but entirely friendly isolation. In 1818 Ajmer, in the centre of Rajputana, became British territory by an arrangement with Sindia. Jhansi accrued by lapse in 1853, and was the last instance in which Lord Dalhousie's doctrine of lapse owing to failure of heirs was applied to a Native State. The twelve Oudh districts were annexed in 1856. Delhi and its districts remained part of the North-Western Provinces until 1858, when under circumstances created by the Mutiny they were transferred to the Punjab. Ajmer was placed by Lord Mayo under the Foreign Department in 1871. In other respects there has been no territorial change since acquisition.

Physical and Other Characteristics.

It is characteristic of life and work in India that to every resident the province with which he is best acquainted is the most interesting in the Indian Empire. I confess that I am no exception to the rule. In his classical book on India, the late Sir John Strachey has given us an eloquent appreciation of the grandeur and glory of Himalayan scenery in Kumaun and Garwhal. The forests beneath the hills; the points in the southern border where the plain rises into the table-land of Central India have beauties which do not fade from the memory; but the province is essentially a plain, and the great alluvial plain of the Ganges from Hardwar to Benares has a special charm of its own. This is the home of the ancient Aryan poetry and civilisation, and its charm is perhaps most readily perceived by those who in the months from November to March live in tents and daily wander from village to village amid its groves, its irrigated fields, and its friendly, cheerful, and hard-working communities. Here are to be found most of the holy places of Hinduism: Hardwar, Muttra, Allahabad, Ajuddhiya, Chitrkot, Benares. Here also was the centre of Mohammedan rule; here are the cities of Fatehpur Sikri and Agra, the imambaras of Lucknow, and the mosques of Jaunpur.

It is believed by ethnologists that after the first swarm of Indo-Aryans had occupied the Punjab a second wave of Aryan-speaking people made their way into India through Gilgit and Chitral, and established themselves in the plains of the Ganges and Jumna, the sacred middle-land of post-Vedic tradition. Here they came into contact with Dravidian races; here by the stress of this contact caste was evolved; here the Vedas were composed and the structure of orthodox Hindu ritual and usage was built up. Numerous Rajput kingdoms were established, and flourished for many centuries, and it is by a consideration of the development, decline, and fall of these kingdoms that we are able to explain the peculiarities of the existing tenures of land, more particularly that of the Talukdars of Oudh and the coparcenary communities of Agra, who exercise a quasi territorial power over other residents in their village. The Mohammedan invaders destroyed the Hindu paramount Empires such as dominated from Delhi and Kanauj, but the old and compact social system of the Hindus was little affected.

Pre-British Conditions.

When we first obtained a foothold in Hindustan the country had, for nearly a century, since the death of Aurangzeb in 1707, been a prey to anarchy. In the districts dominated by the Marathas there was no security outside the military posts. We have a picture of the country from the pen of Mr. Thomas Twining, a Bengal civilian, who travelled in 1794 from Benares to Delhi, *viâ* Agra, and back, *viâ* Aligarh, Futehgarh and Lucknow. He describes the districts between the Ganges and Jumna as depopulated and lying waste. What few men he saw working in the fields were all armed. Bands of Mewatis, Pindaris, Gujars and Rohillas plundered everything that they felt strong enough to attack. In Oudh alone was there some security.

We have also an interesting report dated 10th February, 1805, by Mr. H. Strachey, Judge of Circuit, on the conditions of the country in that year, published as an appendix to the fifth report of the Select Committee on the affairs of the East India Company. He was struck by the fact that robberies were far less frequent than in Bengal, for the people possessed energy and courage to defend themselves and were accustomed to stand by each other. The power of the Chiefs was great; each had a fortress and a military force and many had rendered a very imperfect obedience to the Vizir of Oudh and to the Marathas. The Chiefs had no difficulty in finding brave and faithful adherents, as many as they could maintain. His relatives, dependants, and followers looked on their chief as their sovereign, and no degree of severity could avail to detach them from him. The representative of the ruling power had maintained order, not by courts of justice but by military force, and courts of justice were peculiarly obnoxious to men of rank and high caste, who thought themselves disgraced by being called into court on any occasion, even as witnesses, and who specially objected to the equalising tendency of British rule, which, in their opinion, reduced them to the level of their domestics and labourers.

Here we have a description of a strongly marked aristocratic society, such as we found in Oudh at the date of the annexation in 1856. Yet the most remarkable event in the early revenue history of the Agra Province was the discovery, by administrators from Bengal, of the landlord village with a joint hereditary body of co-sharers. This tenure, which had not been recognised in Bengal, undoubtedly had its main origin in the disruption and dismemberment of the Rajput kingdoms, which, for centuries, had their seat in what is now the United Provinces. The tendency of the Rajput clans and tribes was to form a number of small States, and to divide the villages belonging to the State between the Raja, the head chief, and his kinsmen, the lesser nobles. Each of these took from the cultivators, in his own villages, a share of the produce. The lesser chiefs paid a fee on succession, and each was obliged to attend with his forces in time of war. The great dynasties of Kanauj and Delhi, and even, to go further back, of Chundra Gupta, were probably aggregations of small Rajput kingdoms acknowledging an overlord and bound to help him in his wars.

This is the system of landholding which is described by Colonel Tod in his book on Rajasthan, and which still prevails in Rajputana. Ajmer itself, in the centre of Rajputana, became an Imperial residence, but the Moghul Emperors, from considerations of policy, did not obliterate or interfere with Rajput customs in that district. In Ajmer we found what we are justified in considering a close resemblance to a typical Hindu kingdom. There was the domain of the Raja, called by the Mohammedans "Khalsa," in which the ruler, generally with the help of a headman in each village, took a share of the produce. Every cultivator who had dug a well or made an embankment was considered to have a right in the land improved by him, and not liable to be ejected so long as he cultivated according to custom, and paid the customary share. The remainder of the district was held by minor chiefs, who, in their own tracts, collected the ruler's share, and who were for the first time obliged to pay land revenue by the Marathas.

The Mohammedan conquest of the Gangetic plain destroyed the large Rajput kingdoms and broke up the petty principalities. Part of the clan followed the defeated chief and his family into exile, and helped him to carve out a new, but much poorer dominion in Rajputana. Another part remained in their old homes under the foreigner's rule, but in the dismemberment which ensued on the loss of territorial position, cadets of families would assume independence, and by timely submission would retain at least some of their possessions, no longer as ruling chiefs, but as landlords. The custom of primogeniture would cease with the cessation of rule, and as each family multiplied, land would be distributed

according to ancestral shares in individual villages. It is remarkable that in the "Ayin-i-Akbari," nearly the whole of the Province of Agra is recorded as held by Rajputs in the reign of Akbar. The descendants of these men, even in poverty, still retain the pride and self-respect of an aristocracy, and claim and receive respect from the residents of the villages.

A second source of landlord village communities is to be recognised in the conquest or colonisation of groups of villages by cultivating clans or tribes. This is probably the origin of the large Jat and Gujar communities that exist in the west of the Province and to a still greater extent in the Punjab. In these communities, however, the property is not held on ancestral shares and the revenue obligation is proportioned to the actual holding.

A third but minor source of these communities arose from grants by Rajas of villages to relations or persons who had deserved well but who were not important enough to receive regular territorial allotments in the State organisation. Such grants can be traced in Oudh under the name of *birt*: in Ajmer under the name of *bhum*.

The point to which I wish to draw attention is that the right of the village communities, whether based on conquest and colonisation, or on grants, or on the dismemberment of petty Rajput principalities, was the outcome or shadow of what was once a territorial or ruling position occupied by men of high caste. It was entirely different from the ancient form of right which we meet in Ajmer, which belongs to every cultivator who clears land for cultivation, and who improves his holding by sinking a well or making an embankment. The first right was recognised by us as proprietary right, the second right developed into tenant right.

British Revenue System.

The recognition of village proprietors rapidly became characteristic of the revenue system of the North-Western Provinces. After the first few years farmers were systematically set aside, and the ascertainment of the tenure led to a complete change of view as to the position of the Raja or Talukdar in cases when his authority had been clearly established over a village community. Where separate and different interests were found in the same land the Executive Government decided which party should be admitted to engage for the payment of the revenue, and the tendency was to favour the village proprietors. The leading case is that of Mursan, the whole of which estate was at first settled with the Talukdar. But this was revised. In one-third of the estate the Raja was recognised as proprietor, and settlement was made with him; in the remainder the settlement was made with the village proprietors and an allowance was made payable from the Treasury to the Raja as hereditary Talukdar.

The same question was raised in an acute form on the annexation of Oudh. The first orders were that engagements should as a rule be taken from the village communities, and that the Talukdars should be left to prove their right to superior tenures if they had any. Then, after the first summary settlement, the Mutiny supervened, and the confiscation of estates by Lord Canning in 1858 left Government a free hand to settle with whom it thought best. The Talukdars who submitted received grants and title deeds of the estates of which they were found to be in possession, and though certain subordinate rights were preserved, the final settlement was in favour of the great landlords.

These questions are now matter of history. Things have long since settled down. The Talukdars have treated their tenants well, and in 1886 concurred in legislation to place a check on enhancement of rent and eviction. Had Oudh been annexed in 1803, more village communities would have been in existence and more would have been recognised. But during fifty years of misrule and conflict with the Nawabs of Oudh, the Talukdars had greatly strengthened their position. It was practically impossible for a village community to stand alone exposed to the exactions of an official of a corrupt and incompetent Court. It naturally preferred to be under the protection of a Talukdar, and by 1856 the superiority and influence of the Talukdars had become a necessary element in the social constitution of Oudh.

Our first short term settlements were founded on the excessive demand of a time of anarchy when all trace of a share of the produce, and a valuation of that share in money had disappeared, and in the assured belief that the revenue was capable of indefinite expansion. The assessments even with a large margin of cultivable land were extremely heavy, they professed to take 90 per cent. of the rental, and the sale regulations of Bengal were ruthlessly applied on default. Tenures were misunderstood, and it was supposed that all questions of individual right should be left to

the decision of the ordinary courts of law. Great injustice and confusion ensued, and many and grievous blunders were committed. It was only possible partially to remedy the injustice by a special Commission appointed in 1821. In the following year, Regulation VII. of 1822 laid the foundation of the existing system of survey, record of rights and assessment, and under it the first regular settlement for thirty years was made. It professed to take 66 per cent. of the rental, which it was estimated would reach the proprietors during the term of settlement. More important even than the reduction of the standard of assessment was the final settlement of the question of tenures. In some places, as in Ajmer village communities were created where they had not previously existed, and some of the great landlords found their income and influence largely diminished. But the settlement made stood well the test of the Mutiny of 1857. For some months it may be said that British power was wholly extinct in the Province. The anarchic elements in the population resorted to robbery: the ousted village communities, the families recognised at the settlement, but who had been sold out chiefly by the Civil Courts, drove away the unmilitary purchasers and resumed what they still considered to be theirs. But there was nothing like a general popular war against British rule. Sir George Campbell, who came down as Civil Commissioner with the column from Delhi, states explicitly that there was no symptom of popular resistance or hostility. One or two chiefs offered opposition, but with this exception the column everywhere walked into the villages and met the people as if nothing had happened.

A further development of settlement practice was made in the second regular settlement some ten years after the Mutiny and is chiefly associated with the name of Sir Charles Elliott, at that time Settlement Officer of Fatehgarh. The process of ascertaining assets became inductive. The object was to ascertain the actual rent paid for each well-known class of soil, and the product of the rates into the soil areas classified gave the assumed assets. Half of the assets instead of two-thirds was under executive orders of 1855 now taken as revenue. Much of the labour expended on classification was of permanent value, but the tendency of the method was to be severe on inferior land and precarious areas. The rental assumed was still the anticipated average rental during the coming period of settlement.

The establishment of a Record Department, which annually tests and records all changes in cultivated lands or in rents, enabled the officers who conducted, under the orders of Sir Charles Crosthwaite and Sir Antony MacDonnell, the third regular settlement, to avoid the expense and harassment of a fresh survey and record of rights. No addition to actual assets is now made on account of prospective increase in cultivation on prospective rise in rents. The basis of the assessment is the amount which after examination and analysis of the recorded cash rental the Settlement Officer accepts as equivalent to the fair rental which with ordinary business habits and diligence the landowner can collect one year with another. Excessive rents which cannot be paid in full over a term of years are discarded and the holdings are treated as fields against which no cash rents are paid. The accepted cash rental *plus* the valuation of land for which cash is not paid forms the "assets." The "net assets" are the assets after deduction has been made for improvements and for an allowance on proprietors' cultivation. The standard assessment is half the net assets.

Improvements are nearly all small irrigation works, chiefly wells, and the rule is that all works constructed within the thirty years' period of an expiring settlement shall be exempted from assessment for the period of the next revised settlement. The average exemption is thus 45 years, and it is further provided by rule that the allowance for a new well by deduction from the assets shall not in any case be less than 8 per cent. on the capital expended. This percentage would in thirty years replace the capital into interest at 6 per cent.

It is further provided that whenever the former revenue is increased by more than 25 per cent. the increase must be made progressive over stages of five years.

Improved Revenue Collection.

I turn now from the assessment of the land revenue to recent improvements in the system of collection. The standard mode of management is one under which the revenue is imposed in cash as a fixed sum to be collected annually without alteration during a series of years. In all ordinary years the demand is punctually paid, and only in rare cases is it necessary to inquire into the cause of an arrear or to resort to any process for its recovery. But in cases where there is a general failure or destruction of crops by drought, frost, or flood, conditions

exist under which it is just and necessary to relax the settlement contract in view of the necessities of the person who entered into it. The famine of 1896-97 brought the question prominently to notice, and the Government of Lord Curzon adopted the following principles to be applied to wide-spread calamities :—

Relief is ordinarily required if there is less than half a normal crop, and if the crop is less than a quarter of a normal crop the relief should extend to the total current demand.

Suspension or postponement of revenue should be the rule, but remission should be given when, with reference to the condition of the people and the nature of the tract, it is practically certain that it will be impossible to collect the arrears.

Relief must be given promptly, and notice of it communicated to those who have to pay before the day when the revenue is due.

A proportionate measure of relief must be extended to tenants, and where this is done no discrimination should be made between different classes of landlords. All should obtain the relief.

In Bundelkhand, the condition of the country is recognised as such, that relief is given only in the form of remissions, a method of relief which is a far more efficient stimulus to industry than suspensions. This is a tract of country which is specially liable to vicissitudes of season and to great variations of produce. It suffers almost equally from drought and from excessive rainfall, and is exposed to long periods of depression and disaster which cannot be averted by good husbandry. The land is held by large cultivating communities, and the prosperity of the district is bound up with the existence of these communities. When they have been broken up or dispersed, recovery, even with a series of good years, is very slow. After the last famine, a special summary revision and reduction of assessment was made, and this was followed by a regular settlement in which provision has been made for giving a more or less automatic elasticity to the demand. Land broken up within three years has been separated from the established cultivation, and assessed at low rates. The area under cultivation is yearly examined, and in case of serious defect, the demand will be revised by rates fixed at the time of settlement, and applied to the actual area.

Irrigation.

Bundelkhand is beyond the reach of the canals, which derive their supply from snow-fed rivers, like the Ganges and the Jumna, but it is commanded by rivers which flow northward, into the Gangetic plain, from the plateau of Central India. Some of these are mighty torrents in the rainy season, but the supply runs short in the cold weather, and for irrigation at that time it must be supplemented by storage reservoirs. A canal from the Betwa, to irrigate the Jalaun district, was opened in 1885, and proved of great value during the famine of 1896-7, and the drought of 1905-6. A supplementary reservoir on this canal is now nearly completed. Two new canals have been sanctioned. That from the Ken river will irrigate the Banda district; it was opened in December, 1906. The second canal is from the Dhasan, to irrigate the Hamirpur district, and this work is in progress. These works are not expected to be directly remunerative, but their protective value is enormous, and fully justifies their construction. Besides irrigation from canals much help to this very precarious part of the province can be provided by the construction of what are called tanks, and in March, 1905, a special tanks' division was constituted for Bundelkhand. The object of this branch of the Irrigation Department is to store, by means of embankments across a catchment basin, the rainfall, which would otherwise run to waste down a slope. In this way a supply in wells is ensured, and in the case of larger works there is direct irrigation of the land below the embankment. Many admirable works of this kind were carried out by the former Chandel Rajas who ruled in Bundelkhand, and good progress has been made in the restoration and repair of these old embankments, in the construction of tanks on new sites, and in the formation of large field embankments, which retain moisture in the bed of the tank, but do not give direct irrigation. I have seen a report from the officer in charge of these tanks, which goes to show that the value of the produce grown on the land under the new tanks during the present year of drought, and which would not have grown at all but for the construction of the tanks, equals if it does not exceed the capital cost of the embankments.

Rent Legislation.

Parallel with the progressive reduction of the standard of revenue demand there has been continuous rent legislation which by restricting enhancement preserves in the hands of the tenants a part of the increased income which

otherwise would be assessable as land revenue. The last Rent Act was passed in 1901, and the object of the rent legislation is to ensure fixity of tenure at a fair rent. It accepts the legitimate influence of competition but seeks to confine that influence within reasonable limits. The tenant-right cannot be sold for debt nor transferred to a stranger, but it is hereditary, and is sufficient in practice to justify as much credit as is necessary for cultivation. Except in the matter of free sale the law has created a tenure similar to that created in Ireland by Mr. Gladstone's legislation of 1881. In Ireland the tenure proved unstable, and all parties have united to destroy dual ownership, but there is no indication in the United Provinces that the present form of tenant right is merely transitional.

Agricultural Indebtedness and Co-operative Credit Societies.

The question of agricultural credit is closely connected with the land revenue administration, and in India the State has always considered it one of its functions to make advances to cultivators. The agriculturist cannot carry on his work without credit. He trusts his seed to the earth, but has to wait till his crop is ripe. The holdings of the village communities and tenants are small, and are gradually becoming smaller by sub-division among heirs. The farming classes as a rule have no capital, and the unorganised local credit on which they depend fails when the harvests fail, or there is a serious prospect of failure. In times of general drought the State must intervene, and in the present famine the expenditure on advances for seed, cattle, and irrigation exceeded £1,000,000. One effect of British rule was to make rights in land transferable for debt, and this effect was specially noticeable in Jhansi, where, before 1853, the cultivating communities were not able to borrow money on the security of their land, but where the new security offered by ownership, coupled with the uncertainty of the seasons and the excessive rigidity of collection of a fixed demand, led to great and general indebtedness.

In 1882, an attempt was made by Government to clear the encumbered estates in Jhansi by the appointment of a special Judge to adjudicate on debts, and by the provision of loans to clear the encumbrances. In 1903 a similar Act was passed for the whole of Bundelkhand, and this measure was coupled with a very needful restriction of the power of alienation. By the Land Alienation Act of the same year land in Bundelkhand, belonging to agricultural tribes, ceased to be liable to sale in execution of a decree of any civil or revenue court. The proprietors, however, still possess the power of usufructuary mortgage for a term not exceeding twenty years.

Another mode of dealing with agricultural indebtedness is now on its trial throughout the province. Experience has shown that cheap credit, without due prudence in its use, leads only to quicker ruin, and that it is essential that any system of credit should develop thrift, prudence and self-help. In Europe, the indebtedness of the small farmer has long been a subject of grave anxiety, and the experience of many countries in Europe shows that the desired end can best be attained by the establishment of co-operative credit associations on the Raiffeisen system.

In Mr. Theodore Morison's excellent book, entitled "The Industrial Organisation of an Indian Province," are two very interesting chapters explaining this system of mutual help, and quoting largely from the memorable report on land and agricultural banks by Sir Frederick Nicholson.

In Ireland also co-operative credit associations have been established under the auspices of the Irish Agricultural Organisation Society. I may quote Sir Horace Plunkett's account of these societies, from his book, "Ireland in the New Century."

"The exact purpose of these organisations is to create credit as a means of introducing capital into the agricultural industry. They perform the apparent miracle of giving solvency to a community composed almost entirely of insolvent individuals. They have no subscribed capital, but every member is liable for the entire debts of the association. Consequently the association takes good care to admit men of approved character and capacity only. It starts by borrowing a sum of money on the joint security of its members. Loans are only made to members and for purposes which in the opinion of a committee will enable the borrower to repay the loan. Raiffeisen held that in the poorest communities there is a probably safe basis of security in the honesty and industry of its members. This security is not valuable to a local joint stock bank, but it is valuable to a bank that has intimate knowledge of the character and capacity of the borrower."

In India the village money-lender and grain dealer has that intimate knowledge, and for centuries he has financed agriculture on no greater security than his trust in the honesty of his clients. His trust has seldom been disappointed, but his terms are hard, and he is himself a poor man with very little capital.

There is ample room for local co-operative credit associations, and strong village communities are a specially hopeful field for their working.

Their greatest value, as Mr. Morison says, lies in their educative action. They are the germ from which co-operation in its varied forms most easily and most often grows. From the modest beginnings of a bank it is hoped that the peasant proprietors will learn to associate for the purchase at wholesale prices of implements, manure, cattle, and seed, and proceed to co-operative production and sale.

In 1904 an Act was passed for the constitution and control of such societies, and a special officer, called the Registrar, has been appointed, under the Act. The movement has so far only touched the fringe of the vast population concerned. In the whole of India there are only 90,000 members of existing societies, and these represent but a minute fraction of the numbers that must eventually be brought within the scope of the reform if co-operative credit is to produce any marked effect on the problem of agricultural indebtedness. But the report for the United Provinces issued in 1908 is satisfactory, and even more hopeful than had been anticipated. Rural credit societies increased in one year from 49 to 130, and district and town banks are springing up and are collecting a floating capital which they lend to the village societies. It is becoming recognised that the combination of village societies for the purposes of finance and control is as important as the combination of individuals for the purpose of forming a single society.

Government Agricultural College.

The empirical art of agriculture is thoroughly understood by the cultivators of the province, and, so far as traditional knowledge can guide them, they know their own business better than the officials or landlords with whom they have to deal. Accumulated experience which has crystallised into a custom is usually a safe guide to making a living, and cultivators on a very small scale cannot afford to risk much in experiments. In recent years there has been a marked change in the attitude of Government towards agriculture. Till lately there was a complete ignorance among the people of the principles of science which explain and justify the empirical art, and suggest measures for its improvement. Technical education in agriculture is now pushed on at Cawnpur, where the agricultural school was last year developed into a Government agricultural college. Much has been done to help the cultivator by depôts for selected seed, by cattle farms, by arrangements for boring wells, by exhibition of improved processes of sugar manufacture, by demonstrations on farms of new crops or new implements. The present Director of the Department, Mr. Moreland, is a man who has made the subject his own, and who in 1904 published a valuable manual on the agriculture of this province. He has been ably assisted by Syed Mohammed Hadi, and the establishment of the new college will give a stimulus to research. It is to be hoped that the research of the Agricultural Department will show the best way to combat the plant diseases and pests, especially caterpillars and fungi, to which growing crops are exposed; and as in the case of sugar-cane, discover varieties on which the fungus or insect cannot live. If this could be done in the case of wheat-rust, a great practical benefit would be conferred on the agriculturist.

Similarly, in the cases of the cattle diseases of anthrax and rinderpest, the services of the Muktesar Laboratory, near Almora, have developed a protective serum the value of which has been proved, and which it is hoped will before long be generally adopted.

Famine.

Another matter to which I may refer is the responsibility undertaken by the State for mitigating and alleviating the suffering caused by drought. In former days war, rapine, and misrule were causes of famines and of the desolation of great tracts of country. Now drought is the enemy to be dreaded, and it is beyond human power to prevent drought or to prevent drought causing such an interruption in agricultural industry as brings on famine conditions in an agricultural country. There is no Poor-law in India, and in ordinary years the indigent are not relieved from public funds. It is one of the matters in which India may justly glory that private charity suffices. But in the case of widespread distress private charity is unable to supply a remedy, and the principles have been accepted that the State must intervene to prevent any loss of life—that relief must be adequate to the necessities of the people, and must be continued till normal conditions of employment are restored and a demand has again arisen for agricultural labour. These principles were most successfully carried into effect by Sir Antony MacDonnell in 1897, and the arrangements then

made have been embodied in a revised code. A modern famine campaign as carried on by Sir Antony MacDonnell, and in the present year by Sir John Hewett, is a truly remarkable administrative achievement. It relieves but does not pauperise the distressed, and leaves scope for private beneficence. I mention the subject, not so much to explain the system of administration as to note the degree to which responsibility has been assumed. The famine of 1896-7 cost £2,000,000; the estimated expenditure for the prevention of the famine to which the province is now exposed, including advances and loans, remission and suspension of revenue, exceeded £4,000,000. It is well understood, however, by the people that advances must be recovered, and that suspended revenue will be collected as soon as there are crops from which it can be paid. The number of persons on relief on 14th March, 1908, was 1,411,796. This was the highest figure reached, and after this there was a decline owing to the harvest. The highest figure in 1897 was 1,696,722

Though there was no rain from 29th August, 1907, till 10th January, 1908, yet fortunately there was general rain on 10th and 11th January. This rain saved the crops in many places, provided a welcome respite to the overworked cattle, and also gave a start to the growth of much-needed fodder. Owing to the rain and the industry of the people in making wells, and in irrigating their fields, the estimated outturn for the whole Province is as much as 65 per cent. of a normal crop.

The Land Revenue Administration, then, has added many complicated functions to the simple organism for absorbing revenue of early days, when the demand was 90 per cent. of the assumed assets, and the only mode of dealing with default of payment was to sell by auction the proprietary rights that had just been recognised.

The land revenue demand has become progressively moderate in assessment: protection has been given to improvements until the landowner, from increased profits, shall have replaced his capital. The cause of default is carefully ascertained, and in all calamities the collection of the revenue is marked by increasing consideration. Sale of landed property for arrears (a purely Western idea) is of the rarest occurrence. The establishment and revision of the rent law has been steadily in favour of the tenant. State loans at low interest are given for improvements and for purchase of seed and cattle, and attempts are being made to start co-operative credit societies. Railways and irrigation works which are not expected to be remunerative are carried out, so that food grains may move freely to afflicted tracts, and, where possible, the crops may be protected from drought, and migration from over-crowded districts may be facilitated. Anarchy in short has given place to rule, and the State has resumed the control which in Bengal had been abandoned to the zamindars. An ever-increasing knowledge of and sympathy with agricultural conditions have expanded the operations of the State, and the public demand for land has been limited, so as to secure the interests and contentment of the taxpayers without at the same time alienating future increment by a permanent settlement. The State has reserved to itself all rights in minerals, but the land of the province has not been nationalised. Private property in the surface of the soil has been recognised, and apart from forests the cultivable area owned by the State is insignificant. On the other hand, every landowner is obliged to pay annually a tax equal to half the fair rental of the land. This share of the rental is never likely to be reduced, but subject to its payment the landowners have a complete security of tenure.

All these measures have given confidence to the people that in times of distress the State is prepared to protect and aid them with its resources. During recent severe droughts the bonds of society have not become relaxed, there has been no feeling of panic and no outbreak of violent crime. Aimless wandering of starving people in search of food has ceased. During the famine of 1897 the law-abiding and patient spirit displayed by the people was specially noted, and at the commencement of the existing distress every District Officer reported the courage and steadfast industry with which the people faced the threatened calamity, not giving way to despair, but doing all in their power by irrigation from wells to bring as large an area as possible under cultivation.

Absence of Political Unrest.

I have dwelt at some length on the management of the land because more than any other it affects the welfare and happiness of the population, 70 per cent. of whom derive their living from agriculture. If I am asked the reasons why the United Provinces have hitherto escaped the unrest which has agitated Bengal I should certainly adduce as a principal cause

the superiority of the revenue administration over that which is possible in the sister province. In the United Provinces the District Officer and his assistants are compelled by their revenue duties to be in close touch with every class of the agricultural community. The Government appears not merely as a tax collector, but as sharing with its subjects in misfortune, and the District Officer is a friend who has earned the trust and confidence of his district and of the natural leaders of the people.

The True Swadeshi.

While a great advance has taken place in making things easier for the land-owning and cultivating classes, little has yet been done to improve the position of the agricultural labourers, a large class who are multiplying beyond the requirements of agriculture, and who are the first to need relief on the occurrence of scarcity. It was recognised by the Famine Commission, in 1880, that no remedy would be complete which does not include the introduction of a diversity of occupations through which the surplus population may be drawn from agricultural pursuits, and led to find the means of subsistence in manufacturing and other employments. It is in this direction that the Province is now moving. It is a line of action in which the best men of the educated classes take a prominent part, and co-operate heartily and harmoniously with the Government. There is enough capital; what is wanted is business enterprise and industrial initiation. The production of coal, coupled with the extension of railway communication, has removed one of the chief obstacles to industrial progress. Facilities of locomotion do even now render the poorer classes less unwilling to leave their homes if they can get work elsewhere, and while every effort is properly made to increase the productiveness of the soil, it is in the growth of a non-agricultural population, and improvement in the processes of manufacture, that the best hope for the future lies. This is the true "swadeshi" which deserves and receives all help and encouragement from the local Government and the Government of India. Much may be done by united action which is difficult or impossible for individual effort, and though Government can aid in many ways, yet the starting of industrial progress must be the work of the leaders of the people.

Educational Progress.

But there are many signs of the development of the spirit of self-reliance and self-help which contains within itself the promise of great results in the future One notable example is the success of the Mohammedan-Anglo-Oriental College at Aligarh. The conception and foundation of this college are due to a single man, Sir Syed Ahmad Khan, who devoted his life, his great abilities, and his worldly means to the solution of the problem of the higher education of Mohammedans. His aim was to establish a college which would not only impart the instruction needed for success in the business of life, but which would contribute to the formation of a religious, virtuous, and upright character. Residence in the College and manly sports of all kinds were encouraged. Sir Syed Ahmad gathered around him many friends and lived to see the assured success of his influence; and on his death, in March, 1898, his friends united to carry on his work. Of late years great progress has been made. New class-rooms and new hostels have been built for the ever-growing number of students, a school of experimental science has been fully equipped, and provision has been made for the higher study of Arabic. Much of this progress is due to the untiring energy of the successor to Sir Syed Ahmad Khan in the office of Secretary, Nawab Mohsim ul Mulk, whose loss we deplored this year, but many friends co-operated with him, and among them I mention His Highness the Nizam of Hyderabad, His Highness Aga Khan, Sir Faiyaz Ali Khan, the Raja of Mahmudabad in Oudh, and his own successor, Nawab Mushtak Hussain.

Another remarkable instance of self-help is the Central Hindu College at Benares. This became a first-class college in 1898 and now numbers 600 students. In the words of the Board of Trustees, the Central Hindu College "seeks to inspire its students with pride in their country's past and hope for their country's future; while it inculcates that loyalty to the monarch of the State which is the natural and spontaneous feeling to the Indian heart. It seeks to encourage manly, self-reliance and civic virtue and to base these on the sure foundations of reverence to God and love to man." The President of the Board of Trustees, Mrs. Annie Besant, at an early stage of the unrest in Bengal prohibited all students from taking an active part in political controversy and agitation. Her orders were obeyed, and were fully approved by the parents of the students.

I may instance also the action taken by the Meerut, Agra, Lucknow and Bareilly Colleges to improve their boarding houses, the admirable Hindu hostel which was built by subscription at Allahabad in connection with the Muir College, and the new Sanscrit Library, at Benares.

Another instance, is the fact that the Province subscribed 12 lakhs of rupees, or £80,000, for a medical college in Lucknow, as a memorial of the visit of H.R.H. the Prince of Wales. The college, with the necessary hospital and other buildings, will cost much more, but the plans and estimates prepared by Sir Swinton Jacob have been approved, and Sir John Hewett has undertaken to carry out the work as a provincial project. It will, I hope, be finished before the expiry of his tenure of office as Lieutenant-Governor, and the province will then have, what it has needed for the last forty years, a first-class medical institution where students, both male and female, can be trained for the professions of medicine and surgery. Hitherto students from the United Provinces have been obliged to seek higher medical education, either at Lahore or at Calcutta.

Social Reform.

Another sign, full of promise for the future, is the establishment of non-political sabhas, or associations, which aim at the improvement of the position of the members, and at the abolition of customs which experience has shown to be injurious. The association of the Vaishya, or mercantile middle-class, desires to reform the marriageable age of boys and girls, to curtail ceremonial expenditure, to promote female education, to foster a spirit of mutual help by the amicable settlement of disputes, to encourage Hindu and Sanskrit learning, and to develop among the people a spirit of enterprise in trade and industry. The association has founded an orphanage to give a training and start in life to orphans of their caste.

Other associations are those of the Rajputs, the Jats, and the Bhumihar Brahmans of the Eastern Districts. In an address presented to me on my departure from India the Rajput association referred to the sentiments of loyalty, fidelity, and devotion to duty which chracterise the warlike race of the Rajputs. Their aim is to introduce an era of reforms calculated to promote fraternal feeling, and to raise the intellectual, moral, and social condition of the community. To this end a Rajput High School was established in Agra in 1899, and a scheme has been launched for the establishment of a first-grade Rajput College.

As a mark of moral progress among the Rajput clans may be cited the fact that, in 1906, it was possible to abrogate the special regulations directed against female infanticide in 1870. In 1874, the population under special preventive measures was 359,000. In 1887 it was still 200,000. In 1891 it had fallen to 62,000. Ten years later the Act was in force in only 264 villages and in many of these the numbers were so small as to furnish no trustworthy test of the existence of the practice of the crime. There is now a due proportion of girls among all the suspected classes, and it is hoped that the practice has ceased to have the support of custom and that the ordinary law is sufficient to prevent it again becoming prevalent.

Sanitation, Water Supply, and Improved Dwellings.

The mortality from plague, and the high death-rate that now obtains, have directed the earnest attention of all interested in the welfare of the people, to the need for the improvement of the sanitary conditions of towns and villages. The United Provinces have more large towns than any other Province of India, and the late Sir Auckland Colvin will always be remembered for the work carried out during his term of office to provide a supply of pure water in the principal cities. Some of the audience may recollect that, in 1894, Sir Auckland read a paper before this Society, on "Municipal and Village Water-Supply and Sanitation in the United Provinces."

The introduction of a plentiful supply of water showed how necessary it was to improve the system of drainage. Benares and Cawnpur have been provided with underground sewers, and in all towns great progress has been made in pavements and drains. But much still remains to be done, and the resources of the municipal boards are already strained to maintain the existing works and establishments in proper efficiency. In addition to drainage and paving, and expansion of the water supply, there are two directions in which action is being taken, which it is hoped will, in time, have a momentous effect on the public health. These are the opening up of congested insanitary areas in the large towns and the construction of model dwellings. A sum of five

lakhs has been provided in the provincial budget of the coming year in aid of permanent sanitary improvements in the large towns. The urban population thoroughly appreciates the advantages of good sanitation, and the need is more urgent than in the rural areas. The need indeed is great, and has often been brought to the notice of the Government of India by the members of the Viceroy's Legislative Council.

Conclusion.

It is impossible to live among the people of these Provinces without feeling for them, whether Hindu or Mohammedan, a high degree of respect and affection. They are a people pleasant to work with and for whom it is a pleasure to work. At times, indeed, a gust of religious passion seems to sweep over the country and leads to riots which must be firmly repressed. But the people are essentially peaceful, law-abiding, and kind-hearted. Their charity to their poor relations and friends, especially in times of scarcity, though in details it may be small, yet as a whole, is very large, and is given without stint or grudging from a sense of duty with no expectation of receiving anything in return. Sir John Strachey singled out "honesty" as the most striking characteristic of the people, and has noted the politeness and absence of servility in the manners of all classes. Friends, no doubt, are easier made in youth than at a more advanced age, but though the life of many of my early friends has closed, I am proud to believe that I count many friends among the residents of the United Provinces.

DISCUSSION.

Sir Charles H. T. Crosthwaite, K.C.S.I., remarked that the author and himself had been much together in their service, and as young men had been employed in the same branch of work, the settlement of the revenue, that is to say, the survey and valuation of the great estates belonging to the Government, for the Government was the supreme landlord of the whole of the provinces of Agra and Oudh. Most of the paper had been concerned with the subject of land; and necessarily, for the provinces consisted of a huge conglomeration of agricultural villages. The whole life of the people was bound up with agriculture, and the main effort of the Government was to preserve the cultivators in prosperity, and to keep the land in good condition by irrigation or otherwise. At the commencement of British rule the methods employed in land administration were very crude, and hearing the account given by Sir James La Touche, people might be inclined to condemn the Government of that time as wanting in foresight or care for the people. But our officers were pitch-forked into a newly annexed territory, which had been for a considerable time in a state of absolute war and anarchy. They had nothing to guide them, and the records available were worse than useless, for the native Governments had exacted every penny they could from the unfortunate cultivators. At first the people themselves, instead of giving us any aid, endeavoured in every way to deceive us. In the circumstances it was not surprising that for a time the cultivators were overtaxed. But, as the author had pointed out, that state of affairs did not last very long. Most of the provinces were not taken possession of until 1813 or 1815, and in 1822 the great reform of the Land Revenue took place. It was little short of fifty years since he joined the Bengal Civil Service in the United Provinces, and he served there for twenty years. He then left and returned after an interval of seventeen years, so that he was able to some extent to judge what progress had been made. He said to some extent, because a man in the position of the head of the Government could really see little compared with what a man saw whose work brought him in actual contact with the people. They were the men who did see what was going on, and who most influenced the people by their conduct and their actions. There was the Secretary of State in Council, the Viceroy and his Council, the Lieutenant-Governor, and the Board of Revenue, and Commissioners of Divisions. But the man who really governed the provinces was the District Officer, and if that officer was not efficient he (the speaker) defied the Executive Council, or the Viceroy, or the Lieutenant-Governor, to get anything done at all. As the author had said, a good District Officer was a friend of the people in his district, and respected by them. On the other hand, a bad District Officer could do infinite mischief, but there were very few, he believed, who had failed in their duty. Indian Civil Servants were obliged, by the nature of the case, to rise to their responsibilities; and the greatness of the task imposed upon them brought out in even the weakest and poorest of them some sort of ability to cope with their work. The improvements which had taken place in the management of the revenue, in looking after the people, in giving them necessary remissions and suspensions, had been going on steadily for a long time, and what had taken place during the last few years had not been innovation, but progressive improvement. And that was true not only in regard to revenue methods, but also in regard to the native services—that great body of men who really governed the country, magistrates, deputy collectors of the revenue, and the police, who outnumbered the English officials by ten to one. For twenty complaints of partiality, corruption, laziness, and inefficiency, which might have been brought

against public servants in times past, there was only one at present. A Commission had lately reported on the misdeeds of the police in India; but he believed people in any country would give evidence against the police. He remembered the Indian police since 1858, and formerly torture, more or less in a mild way, to extort confessions, was not uncommon. But that state of things did not exist now. The administration of justice and of the police, was purer, and so far as he could see the condition of the people generally was much better. It might be asked, if the conditions of the country had been so much improved, why were there so many famines? But no one, not even a Viceroy, could call down rain from heaven. Everything had been done in the matter in the way of irrigation canals, and even works which were not remunerative in a commercial sense were carried out. Improved communications — when he first went out to India there were only about 150 miles of railway in the United Provinces—very much lessened the hardships caused by the scarcity of water in any particular district. He agreed with the author that agriculture should be supplemented by other forms of employment, but doubted whether much could be done without a change in the fiscal system in India. Could a country like India, which possessed comparatively little capital, establish its own manufactures if it had to compete against all the old-established wealthy manufacturers of Europe? His own belief was that it could not. The solution to the famine question was to get the people off the land—there were too many people on it.

Mr. Theodore Morison said there was one point in the paper to which he would like to call attention, and which he hoped the author would, on another occasion, deal with at greater length, namely, the Associations of Self-help among the people, which had produced such a very great change in modern society in India. At the present time very little attention had been paid to those associations, and hitherto they had not had their historian; but he was perfectly sure that when the history of modern Indian civilisation came to be written, those associations would require a very large chapter. There was another important point to which he would refer. It was constantly said that there were no political institutions in India, and that was frequently used as a reproach against the Government. But, after all, what were politics? They were very little more than associations of men gathered together for public ends, and such associations were, it seemed to him, just beginning in India. Certainly nothing of the kind existed until a comparatively recent period. The associations alluded to appeared to indicate that the people of India were beginning, slowly and tentatively —and as the author had said only in certain castes —to have that mutual confidence and that loyalty and co-operation, without which no political movements were worth anything at all. He did not want to dogmatise, nor did he feel at all sure what political conclusion should be drawn from the fact he had mentioned—but he did think that, in considering the political status of India it was extremely important to realise in what manner the people had already associated together for public ends, and also the progress those associations had made.

The Chairman (Sir William Lee-Warner), in moving a vote of thanks to the reader of the paper, expressed his agreement with Mr. Morison that Sir James La Touche had touched upon most of the important features of his subject in a suggestive manner. A whole paper might be written upon his brief historical reference to the fact that there were only two Native States in the Province. In Bombay there were more than 300 Native States, and here under the shadow of the Mughal Empire at Delhi only two survived. The British Government conserved the Native States and knew how to unite them to itself as royal instruments for governing India. The Grand Mughal swallowed them all up, and when he had brought the whole country under his rule what miseries did the break up of that rule entail! The Book of Revelation had described with the fall of the powers of heaven some of the revolutions and plagues which the United Provinces had endured before the British power restored order to it and gave it peace. The courtiers, officials, and hangers-on of the fallen empire were turned loose on the country. What they did not take the devastating gangs of Marathas snatched up. The only flicker of life which survived in the province was the village community, and upon that the British had wisely built their administration. From that small spark the fire of a new life had spread over the land; and although nature frowned on the province, at times bringing famine and floods, yet the Company had bound up the broken limbs of its rural society and given deliverance to the oppressed peasantry. Everything turned upon what we had done and could do for the cultivating classes, and, therefore, Sir James had wisely dealt with the revenue systems, famine relief, and agricultural credit. At this late hour he (the Chairman) would not enter into details, but he must offer some remarks upon co-operative banks. No one desired more than he himself to see them succeed. But there was a tendency to be impatient and to take hasty count of results, which might prevent their success. If the foundations were not truly laid, these new banks must inevitably fail. The Mysore State had been the first to give them trial, and its experience confirmed the need for caution. The latest reports from Madras constantly dwell on the need for "official countenance and aid." By all means let us give aid, but if the movement is to be wholly sustained by official hands, it ceases to be co-operative. The Bengal reports honestly admit that "the capital of the banks is not made up of savings," and that proof has not yet been given that these societies will be self-supporting. The gist of the matter was, in the Chairman's opinion, this—if the agricul-

tural banks in India are not "the people's own," if control and supervision by the local committees are not to be got, if neither interest nor principal is regularly paid, if eagerness for business leads to doubtful bills, they will only fail, and the old takavi system would have been better. We must proceed slowly on right lines. Happily the attention paid to revenue administration in the United Provinces, brought the British officials, as in Bombay, into closer touch with the Indian people. There was a party in India—which called itself national—whose main object was to inflame racial prejudices, misrepresent the aim of British administration, and deceive the masses by false news. The best antidote to that was the British officer in his camp on tour showing himself, his conduct, his example, and his work to the people. There was no lack of sympathy between British officers and the manly, industrious, patient cultivators whom Sir James had described. The Indian civilian gave his health — and often his life—to his Indian work, and the villagers saw and appreciated it. But there were millions who could not judge for themselves, because the number of British civilians were far too few for the vast field of labour. The agitators sought by misrepresentation to persuade those who had no personal knowledge of the District Officer that he was a cruel autocrat, a spreader of plague and famine, and unsympathetic. All we could do was to persevere, and in the midst of this campaign of falsehood be faithful to our great trust, and so show by the undeniable results of British rule that it still brought to India the prosperity and peace needful for the slow growth of a real national regeneration.

A hearty vote of thanks was accorded to Sir James La Touche for his excellent paper.

HOME INDUSTRIES.

Railway Rolling Stock Construction.—Attention was recently directed in these Notes to the contention of an expert correspondent of *The Times* that an enormous wastage of power takes place by railways misdirecting their energies in competing with manufacturing firms. It was not to be expected that an indictment of the kind would pass unchallenged, and defenders of the system have not been wanting to show that the railway companies are well advised in their competition with manufacturing firms. It is difficult to get the necessary data to form an opinion as to whether the railway companies do the work cheaply or not. The accounts, at all events those which are ultimately published, are framed primarily for showing the cost of working and repairing locomotives and rolling stock. No such degree of public obligation exists in respect to the matter of manufacture. It would seem not unreasonable to assume that the work could be done cheaper if not better outside. As the correspondent puts it, the outside manufacturer is placed face to face with first commercial principles, and in open rivalry of competition. Such firms are staffed with men trained to answer these conditions. Their study is the financial advantage of working with as small a capital as possible, watching the markets of raw material, and at the same time keeping their stocks as low as possible. All these conditions are proved in a very short time by the balance-sheet and profit and loss accounts issued to their shareholders each year. It is different with the railway companies. This is the only country where the railway companies are their own manufacturers, and although that does not necessarily prove that they are following a wrong course, it is not easy to discover the circumstances which make a system deliberately rejected by every other great country advantageous in the United Kingdom.

The American Cotton Crop.—The Agricultural Department of the United States in its June report gives the condition of the cotton crop as 79·7, and Messrs. Hubbard Brothers remark that, since 1890, there have been four June reports from the Department giving the condition of the crop as less than 80, and that so far these have never been followed by a large crop. The estimates of acreage vary rather considerably, but they agree in putting it somewhat above those of last year. Messrs. Neill Bros. say their information is not complete, but they are disposed to give the acreage as 33,500,000 as compared with 33,000,000 last year, and 32,049,000 two years ago. Assuming this estimate to be near the mark, the yield this year, at the present season's estimated rate, would be about 11,725,000 bales, or, at the rate of 1904-5, it would give 15,075,000 bales. Probably the actual output will be something between these figures. The International Congress of Cotton Spinners has been discussing what is best to be done when the building of new mills has outrun the requirements of the public while Nature's yield in the cotton fields is falling behind them, without arriving at any clear conclusions. But year by year the peril involved in depending so largely upon the American supplies of the raw material is being more vividly brought home to those interested in the cotton industry of the United Kingdom.

Labour Troubles.—Although the national vote for at once resuming work at the reduction named by the employers has ended the open quarrel between the Shipbuilding and Employers' Federation and the various branches of the shipbuilding trade, industrial matters are still disturbed. The wood workers on the Clyde have been working since the new year at a reduction, but without coming to any agreement to serve for any term at that rate. They now contend that they should receive the same wage as is granted to the north of England men. When the latter went

out they were receiving 38s. 6d., and their employers now offer them 37s. Previous to the reduction at the new year the Clyde men were receiving 37s., and at the time of the lock-out they were receiving 36s. per week. Their present demand, therefore, means an increase of 1s. per week, but the Clyde employers are not likely to agree to it, seeing all the other branches of labour in their shipyards have been reduced. Then on the Wear there is trouble. And apart from the Wear wood workers, the engineers in the North of England are still on strike against the bargain provisonally made by their own executive officials and the federated engineering employers, who offered arbitration, which the men would not accept.

Electric Railway Experiment. — The Midland Railway Company are making an interesting experiment on one of their branch lines, that between Heysham, Morecambe, and Lancaster, a distance of nine miles. In the case of all electric railways and tramways now working in this country the electric energy is used in the form of continuous current. Alternating current is largely used for electric lighting, and on the Morecambe railway it is adopted for the first time in England for traction. The salient feature to the observer is the range of poles along each side of the railway, united transversely by horizontal beams or gantries. From the latter are hung the overhead wires which are the working conductors. Instead of the 500 volts pressure used on tramway overhead wires, these conductors are worked at a pressure of no less than 6,600 volts, which makes the transmission of the power very economical. To avoid risk from falling wires carrying such a tremendous pressure, and also because the district is much exposed to violent storms, the poles, gantries, wires, and attachments are of great strength. The cars collect the current from the overhead wires by a bow contact, and a transformer on the car reduces the pressure to a working level before it reaches the motors. The machinery on the cars is very elaborate, and the vehicles themselves are large and comfortable. The London, Brighton, and South Coast Railway, who are now electrically equipping their Victoria to London-bridge line, intend to use a similar system, and if these two experiments prove its success, it may be expected that it will be installed on many other routes.

OBITUARY.

Sir William Phillips Sawyer.—Sir William Phillips Sawyer, the well-known Clerk to the Drapers' Company, died at Worthing on the 10th of this month. He was born in 1844, and succeeded his father, Mr. W. H. Sawyer as Clerk to the Company in 1870. Very soon after his appointment he was associated with Sir Owen Roberts, the Clerk to the Clothworkers' Company, and Sir John Watney, the Clerk to the Mercers' Company, in the movement for the promotion of Technical Education which resulted in the establishment of the City and Guilds of London Institute in 1878. Many of the early meetings of the members of the Guilds who were interested in the subject were held at the Drapers'-hall, and a full share of the work of organising the movement fell upon Sir William Sawyer. He, and his two colleagues above mentioned, became the first honorary secretaries of the new Institute, and they were all of them, at different times, knighted. This honour was conferred upon Sir William in 1904. In later years the Drapers' Company dissociated themselves from the City Institute, and devoted their efforts to the development of the East London College, into which the classes originally founded at the People's Palace developed under the fostering care of the Company and its Clerk. The Company, during his clerkship, have also contributed largely for other educational purposes, having assisted the older universities as well as King's and University Colleges, London, and other of the newer foundations in the provinces, and having established many scholarships for the further education of students of both sexes.

Sir William Sawyer became a member of the Society in 1881, and it has benefited largely from the liberality of the Drapers' Company, which has contributed both to its general funds, and to those devoted to examination purposes.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 22...British Architects, 9, Conduit-street, W., 8 p.m.

Tuesday, June 23...Faraday Society. 92, Victoria-street, S.W., 7¾ p.m. 1. Mr. J. Härden, "Recent Developments of the Kjellin and Rochling-Rodenhauser Electric Induction Furnaces." 2. Mr. Adolphe Jouve, "New Applications of Electro-metallurgical Alloys."
Anthropological, 3, Hanover-square, W., 8½ p.m.

Wednesday, June 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.
Royal Society of Literature, 20, Hanover-square, W., 8½ p.m
British Astronomical, Sion College, Victoria-embankment, E.C., 5 p.m.

Thursday, June 25...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.

Friday, June 26...Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Paper on "St. Sophia."
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Physical. Meeting at the National Physical Laboratory, Bushey-house, Teddington, 3½ p.m. Demonstr ion and Work.

Journal of the Royal Society of Arts

No. 2,901. VOL. LVI.

FRIDAY, JUNE 26, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

CONVERSAZIONE.

The Society's Conversazione will be held, by permission of the Trustees of the British Museum, in the galleries of the Natural History Museum, South Kensington, on Thursday evening, July 2nd, from 9 to 12 p.m.

The Reception, by Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Chairman, and the other Members of the Council, will be held in the Central Hall from 9 to 10 p.m.

A Selection of Music will be performed by the Band of H.M. Royal Artillery, in the Central Hall, commencing at 9 o'clock.

A Vocal and Instrumental Concert, under the direction of Mr. Harry Tipper, will be given in the Reptilia Gallery from 9.15 till 10.15 p.m., and from 10.30 till 11.30 p.m.

A Gramophone and Auxetophone Concert, under the direction of the Gramophone Company, will be given at the Western End of the Bird Gallery at intervals from 9.15 p.m.

The following portions of the Museum will be open :—

The Central Hall, containing cases of specimens illustrating Mimicry; adaptation of colour to surrounding conditions ; protective resemblance, &c. Also models of the Tsetse-Fly, the Malaria Mosquito, and the life history of the Malaria Parasite. A splendid specimen of the Sea Elephant has recently been placed on exhibition here.

The North Hall, containing the collection of Domesticated Animals.

The Bird Gallery, containing groups of British Birds and Nests ; and in the Pavilion, at the West end, an exhibition of the Land and Fresh-water Vertebrated Animals of the British Isles.

The Gallery containing the Reptiles, including the three gigantic fossil forms *Diplodocus* and *Triceratops* from Wyoming, U.S.A., and *Iguanodon* from Bernissart, Belgium.

The East and West Corridors on the First Floor, containing the Okapi, African Antelopes, and Giraffes.

Light Refreshments will be supplied at Buffets in the North and South Corridors on the First Floor of the Museum.

Visitors travelling by District Railway (or other underground railways in connection) will be allowed free use of the Company's Subway, which leads from the South Kensington Station direct into the grounds of the Museum.

Each member is entitled to a card for himself (which will not be transferable) and a card for a lady. These cards are now in course of issue. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member, at the price of 5s. each, if purchased before the day of the conversazione. On that date the price will be 7s. 6d.

Members can purchase these additional tickets by personal application, or by letter addressed to the Secretary at the offices of the Society, John-street, Adelphi, W.C. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, either lady or gentleman, and must be signed by the member applying for it.

Tickets will only be supplied to non-members of the Society on presentation of a letter of introduction from a member.

It will greatly facilitate the arrangements if members requiring additional tickets will apply for them at as early a date as convenient.

The Council reserve the right of stopping the sale of tickets or of raising the price, if it is found necessary, in order to restrict the number of visitors within reasonable limits.

A programme of the arrangements for the evening will be published in due course.

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The Annual General Meeting for receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments, during the past year, and also for the Election of Officers and New Members, was held, in accordance with the By-laws, on Wednesday last, the 24th inst., at 4 p.m., SIR STEUART COLVIN BAYLEY, K.C.S.I., C.I.E., Chairman of the Council, in the chair.

The SECRETARY read the notice convening the meeting, and the minutes of the last annual meeting.

The following candidates were proposed, ballotted for, and duly elected members of the Society:—

Ahmad, Goolam, Coromandel P.O., Kolar Gold Fields, India.
Barooah, Padma Nath, Tezpur, Assam, India.
Burton, Miss Lucy, 90, George-street, Portman-square, W.
de Silva, W. A., J.P., Darley-gardens, Colombo, Ceylon.
Dixshit, Hon. Hari Sitaram, 1, Hummum-street, Bombay, India.
Dunn, Hon. George Owen William, M.Inst.C.E., Bombay City Improvement Trust, Bombay, India.
Farnan, Francis, 70, Lexham-gardens, Kensington, W.
Foard, Miss Josephine, Laguna, New Mexico, U.S. America.
Hasan, Syed Mahboob, Mozafferpore, Bengal, India.
Headlam, Rev. Arthur Cayley, D.D., King's College, Strand, W.C.
Heslop, Septimus, Beerbhoom - house, Asansol, Bengal, India.
Kellogg, John H., M.D., Battle Creek, Michigan, U.S. America.
Lim Cheng Teik, Khie Heng Bee, Penang, Straits Settlement.
McConnell, John P., Vancouver, British Columbia, Canada.
Mason, Fortunatus Q., East Liverpool, Ohio, U.S. America.
Niedermayr, Julius, 6, Rue Rocherhoart, Paris.
Niedermayr, Rentier, Rosenheim, Bavaria.
Nishizuka, Toyosaburo, President, Korea Oil Company, Seoul, Korea.
Nunn, R. J., M.D., 5, York-street East, Savannah, Georgia, U.S. America.
Paterson, Oscar, 10, Blythswood-square, Glasgow.
Pudumjee, Sardar Nowrojee, Poona, India.
Robinson, Edward Wanton, Hartford Faience Co., Hartford, Connecticut, U.S. America.
Samwell, Nicholas, F.G.S., M.Inst.M.M., care of Alexander Forbes, 71, Phayre-street, Rangoon, Burma.
Smith, Ralph Freeman, 31, Old Burlington-street, W.
Stephens, Vincent Ignatious, 57-2 36 Street, Rangoon, Burma.
Trimborn, Joseph, 10, Sussex-place, South Kensington, S.W., and Durban, Natal, South Africa.
Webb, Hon. Montagu de P., C.I.E., Karachi, India.
Woodward, Ellsworth, Department of Art, Newcomb College, Tulane University of Louisiana, New Orleans, U.S. America.

The CHAIRMAN nominated Mr. J. Henry Monk and Mr. William Marles Power scrutineers, and declared the ballot open.

The SECRETARY then read the following

REPORT OF COUNCIL.

I.—SOCIETY'S TITLE.

It was announced in the *Journal* last January* that His Majesty the King, who is Patron of the Society, had granted to the Society the privilege of prefixing to its title the word "Royal," and that the Society would consequently be known in future as the "Royal Society of Arts."

The Council feel sure that the members will regard this as a fresh proof of the gracious interest taken by His Majesty in the welfare of the Society, with which he has been personally associated for the long period of forty-five years, first as President, and afterwards as Patron.

II.—ORDINARY MEETINGS.

The first Wednesday in the Session, November 20th, was devoted, as usual, to the Opening Address of the Chairman of Council, Sir Steuart Colvin Bayley. The subject selected for the Address was "Lord Clive and his Part in the Foundation of the Indian Empire." Sir Steuart justified his choice by reminding the members that the 150th anniversary of the victory of Plassy fell in 1907, and that the date had been seized upon by Lord Curzon as a fitting opportunity for establishing some worthy memorial of Clive's great services to his country. He also referred to the fact that he himself was a great grandson of the Mr. Daniel Bayley whose wife was a sister of Clive's mother, and in whose house the early years of Clive's boyhood were spent.

At the second meeting, Sir John Cockburn, who from the beginning has taken an active

* See *Journal* vol. lvi., p. 245, 31st January, 1908.

part in the promotion of the Franco-British Exhibition, read an interesting paper on the prospects of the Exhibition, and gave an account of the progress which up to that date had been made in the arrangements. As far as can be seen at present, Sir John Cockburn's anticipations promise to be realised, for the Exhibition, certainly the largest and most splendid of the long series of London Exhibitions, compares well with its predecessors in the value and importance of its contents. What the results may be as regards the other elements of Exhibition success, finance and attendance, cannot as yet be estimated, but there seems every prospect of a satisfactory issue, as the number of visitors will probably exceed that of any British Exhibition.

The following week Sir Edward Brabrook gave a paper on "Old Age Pensions," which was regarded as a most important contribution to the discussion on this subject, and contains very much to which those who are now engaged in elaborating a scheme for such pensions might well refer. Sir Edward Brabrook, like many of those who have given long and careful consideration to the subject, was in favour of a contributory scheme, and he specially supported the plan which was first announced in a letter to *The Times* in September last by Lord Avebury and others.

On the 11th of December, Sir William Ramsay delivered the first Aldred Lecture, the outcome, as is stated in another part of the Report, of a bequest by Dr. Aldred. The lecture, the title of which was "A Radio-Active Gas," dealt with the latest investigations which had been made into the action of radium and other radio-active substances. It may be sufficient here to say that it delighted a large and attentive audience, who, as the Chairman, Sir Steuart Bayley, remarked, were able to appreciate not only the labour which had gone to the verification of all the facts, but the genius and philosophic imagination which had enabled the lecturer to discover the laws which lay behind those facts.

At the meeting before Christmas, on the 18th of December, Monsieur Lucien Hubert, the Député des Ardennes in the French Chamber, gave a most attractive and interesting address in French on "Le Rôle de la France en Afrique Occidentale." Monsieur Hubert is a recognised authority in his own country on Colonial subjects, and it was no small privilege to the Society to have the opportunity of hearing the views of a foreign authority on a subject which Englishmen are wont to consider so specially their own as colonisation. Though we may pride ourselves upon being the most successful colonisers in the world, it is quite certain we have a great deal to learn from the experience which France has gained by the application of a set of ideas widely differing from those by which our own leaders of colonisation are guided.

At the first meeting after Christmas, on the 15th of January, Dr. Kenneth Mees gave the results of his own careful and laboured investigations into the most recent developments of Colour Photography. When the Brothers Lumière announced that they had produced a photographic plate which, without the use of differently coloured screens, and without the necessity for a combination of the pictures taken through those coloured screens, would give on a single plate a truthful representation of the colours of natural objects, the greatest authorities hesitated to accept the fact as true, and those who were most competent to judge of the capacity of the method involved, were least ready to accept as correct the announcement of these results. A very short experience, however, showed that the claims of Messrs. Lumière were entirely justified, and that they had succeeded in producing a plate which combined in itself the necessary colour screens, and the sensitive material on which the light filtered through these screens might act. For a description of the method adopted by Messrs. Lumière, and for the variations of their process, which have been proposed and carried out by other investigators, reference may be made to the paper itself. It may suffice to say that Dr. Mees succeeded in making a very complex and difficult subject entirely clear, and that his description of the various processes, and their relative claims upon the attention of photographers, was both luminous and informing.

The next paper was one of those of which the Society, especially in recent years, has had so many, in which the resources of a comparatively little known country are described by an author familiar with the country and its people. The fact that Mr. Harry Hillman had lived for a long time in Siam, and was thoroughly familiar with it, gave a special value to his attractive paper on that country.

On the 29th of January, Mr. John William Gordon, whose paper on "Patent Law Reform," read on the 28th of November, 1906, is known to have had considerable influence on the Bill, which has since developed into the last addition to the list of Acts for the improve-

ment of the Patent Law, gave his views on the working of the new Act, and its probable results in the immediate future. Mr. Gordon's anticipations are already being justified, and there seems every reason to believe that the provisions of the Act relating to the compulsory working of patents will have a beneficial effect on the industries of the country.

The subject of Aerial Navigation is one that has been prominently before the public for the last year or two, and part of the Society's contribution to the discussion during the past session was the paper read on the 5th of February by Mr. Auguste Gaudron on "War Balloons." Mr. Gaudron is an earnest advocate of the use of the balloon, whether dirigible or not, as compared with its rival, the aeroplane, and he prophesied that before very long there will be a keen contest between the Powers in the building of air ships, as there is now in the building of marine ships. With this in mind, he advocated strongly the desirability of training up a staff of aeronauts, for whilst he thought it would not be difficult to arrange for a supply of balloons in case of war, it would be very far from easy to obtain a sufficient number of men qualified to work them.

The next paper read was on the 12th of February, by Mr. Robert Buchanan, the President of the Staffordshire Iron and Steel Institute, on "The Application of Science to Foundry Work." This was an extremely valuable and practical paper on modern methods, and urged the importance of the adoption of scientific processes, and the scientific education of foundrymen.

Dr. William Martin's paper on "The Law of Treasure Trove," read on the 19th of February, was a very interesting exposition of the law as it now stands which (in view of the prevailing ignorance on the subject) was much needed, together with some suggestions for its improvement. The value of the paper was much increased by some important remarks made in the discussion by the Chairman, Mr. Read, who, from his experience as Head of the Mediæval Antiquities Department of the British Museum, was able to supplement and illustrate much that Mr. Martin had said. The outcome of the paper and discussion appears to have been that while the law, as it is now enforced, is less unsatisfactory than is generally thought, there is still room for improvement. Even, however, without fresh legislation, much might be done if local and antiquarian societies would take the trouble to make known what the regulations regarding Treasure Trove really are. If finders could only be made to realise the fact that they would get more than the mere bullion value of their findings by surrendering them to the proper authorities, it is likely that more relics would be secured for preservation in museums, and a smaller number would be relegated to the melting pot.

In the paper read at the next meeting, of which the joint authors were Professor Hele-Shaw and Mr. Douglas Mackenzie, a matter of pressing and growing importance was dealt with in an able fashion—"The Problem of Road Construction, with a View to Present and Future Requirements." The recent rapid development of motor traffic has produced a need for roads of really quite a different character to those which were provided with the intention that they should be used for horse-drawn vehicles only. It has recently been shown by the researches of Professor Hele-Shaw and others that the action of mechanically driven vehicles, with their rubber tyres, has a specially disintegrating effect on the surface of the road, which requires to be met by special methods of road construction, while the great dust question has also to be dealt with. Local authorities, as appeared from the discussion, are quite awake to the importance of the problem, and are earnestly endeavouring to solve it. In the search for a solution they will certainly be aided by the information conveyed at the meeting.

At the first meeting in March, Mr. Loudon Douglas gave the Society a useful paper on "Modern Dairy Practice." The provision of the large amount of milk required for consumption in great cities is a matter of increasing difficulty, while the necessity for its absolute purity, and the ease with which it serves as a conveyor of disease germs, provides ever-increasing difficulties for the milk purveyor. The treatment of milk, so as to ensure its safe transit from the place where it is produced, its preservation, and its delivery in a sound condition to the consumer, is a scientific problem of considerable complexity, and such papers as those of Mr. Douglas are of great value by affording information to the public of the difficulties which have to be met, and the way in which they are being dealt with.

An engineering question of great importance was dealt with by Mr. Ernest Matthews in his paper read on the 11th March, upon "Reinforced Concrete." The improvements in

methods of building construction are rapidly outstripping the laws laid down by Parliament, and enforced by municipalities, as to the way in which buildings, alike in town and country, may be constructed. As the Chairman, Sir Alexander Binnie, remarked, the present old stereotyped English building laws do not lend themselves to the mode of construction by reinforced concrete, while, he went on to suggest, if such regulations as were now in existence in New York and other American cities could be introduced into this country, there would be a considerable advance in the use of this method of construction. Mr. Matthews's paper contained a very great amount of information as to the way in which steel and concrete are now used, especially in America, for buildings of a very varied character, and showed the advantage, both financially and architecturally, resulting from the use of this important material.

The history and character of Impressionist Painting was the subject of Mr. Wynford Dewhurst's paper, read on the 18th of March. Mr. Dewhurst and some of his critics in the discussion were not absolutely in accord as to the precise meaning of Impressionism, but all were agreed that the account he gave of the recent tendency of modern æsthetics was extremely interesting and useful for students of Art.

A more practical application of painting than that of the artist was the subject of Mr. Arthur Jennings' paper on "Recent Improvements in Decorators' Materials." Mr. Jennings discussed the question of the character and permanency of the materials generally used by house-painters, and suggested that the Society might start a series of practical tests of the various paints in use, by subjecting sample specimens to various atmospheric influences, and reporting on the results.

At the Easter meeting of the Institution of Naval Architects in 1907, held in the Society's rooms, Sir William White described Dr. Schlick's most ingenious gyroscopic apparatus for preventing ships from rolling, the principle of which had been submitted to the Institution three years previously (in 1904) by the inventor himself. A paper on the same apparatus was read before the Society at the first meeting in April, by Mr. M. Wurl, who has been associated with Dr. Schlick in his experimental work. It seems to be quite certain that the system is efficient when applied to ships of a moderate tonnage, and it remains to be seen how far large passenger ships can usefully employ such steadying apparatus. We are, however, promised that we shall soon have steamers, up to 500 tons displacement, fitted with the gyroscope apparatus, and in the almost certain event of such steamers being successful, there can be little doubt that the application of the invention to larger ships is merely a question of time.

At the meeting on the 8th of April Sir William Preece, to whom the Society has been indebted in the past for so many valuable papers and courses of lectures, gave the result of his observations, during a recent visit to America, on Technical Education in that country. There is no doubt that the funds at the disposal of the organisers of education in America are far larger than are provided in this country, and consequently the provision of facilities for technical training are far more lavish. According to Sir William Preece's view the older country is lagging far behind the younger one in its facilities for technical education, and he urged the importation of American ideas into Great Britain.

At the next meeting on April 29th, Mr. Alfred Stead, the Consul-General for Roumania, gave an account of the recent development of that interesting but not very well known country. Mr. Stead's naturally favourable views were endorsed by the Chairman, Sir Percy Sanderson, whose long experience of the country gave great weight to what he said, and by Lord Fitzmaurice, who was also able to speak from a personal experience of Roumania.

The first account of the Phonograph was given to the Society on May 8th, 1878, just thirty years ago, by Sir William Preece, and it was an interesting coincidence that Sir William was in the chair on the 6th of May of the present year, when a paper on the latest forms of the Gramophone was read by Mr. Lovell Reddie. Mr. Reddie gave a clear and interesting account of the various mechanical improvements which have been made in the apparatus, the latest of which is the Auxeto-Gramophone, resulting from the investigations of the Hon. Charles Parsons. The other mechanical improvements were mainly the work of Mr. Berliner.

At the meeting on the 13th of May, Mr. Clayton Beadle gave the Society some very useful information as to the Underground Water Supplies of the Thames Basin, especially in Kent. This water area is largely drawn upon not only for domestic purposes by the Metropolitan Water Board, but also to a large extent for industrial purposes. Abundant

as the supply is, there seems considerable doubt as to whether the amount now being pumped out is not in excess of the safe limit to which it can be drawn upon. Another interesting question was the amount of filtration from the Thames itself, and the possible contamination of underground water supplies in that manner.

The last paper of the session was read on the 20th of May, by Mr. Martin Duncan, the subject of it being the Economic importance of the Study of Entomology. Mr. Duncan has rendered very considerable service to biological study by the improvements he has made in the application of photography to such purposes, and, as the Chairman, Dr. Chalmers Mitchell, observed, "in his hands photography was becoming not only an aid to the exposition of biological science, but a new weapon in the pursuit of biological knowledge." Mr. Duncan's paper dealt for the most part with the conveyance of disease by insects, and the methods which have been adopted for its mitigation.

III.—Indian Section.

The complaint unceasingly made that the public are not only ignorant but incurious about our rule in India is not entirely supported by the experience of the Indian Section. Certainly no department of the Society seems to attract more general attention and no meetings are larger or more influential than those of the Indian Section. Moreover, a marked feature of these meetings is the increasing attendance of members, members' friends, and specially-invited visitors who have no connection with India but nevertheless eagerly avail themselves of the opportunities the Society affords of hearing regularly from the best experts about that country or rather congeries of countries. Forty years have passed since the Indian Section was established, and amongst the authors of papers read during that time, and numbering some 250, have been four Governors (Sir Bartle Frere, Sir Richard Temple, Sir Mountstuart Grant Duff, and Lord Lamington) and ten Lieutenant-Governors (Sir George Campbell, Sir Auckland Colvin, Sir James Lyall, Sir Charles Elliott, Sir Alfred Lyall, Sir Charles Stevens, Sir James Bourdillon, Sir Thirkell White, Sir Frederic Fryer, and Sir James La Touche), as well as other high functionaries and leaders of the great non-official community. In only five sessions since 1869 have there been fewer than six Indian papers. In two sessions there were eight, and in ten the number was seven. This represents an output of which the Society has reason to be proud.

Indian Agriculture, an industry which in the form of land rent supplies the Sircar with a third of its revenue, has been the subject of many of the most instructive of the Society's papers, but it has never been more ably dealt with than by Mr. Henry Staveley Lawrence, in the paper he read early in the past session. As Director of Agriculture in Bombay when the policy initiated by Lord Curzon came into operation, Mr. Lawrence was in a position to speak from personal knowledge of the "preliminary spade work," especially in the Western Presidency. For the first time scientific teachers, recruited from Europe, were appointed to the Department of Agriculture; existing agricultural colleges were or are being modernised, and new colleges have been founded in other parts of the country. Although these and similar reforms have involved increased expenditure, amounting in Bombay to £35,000, and in all India to between £100,000 and £200,000, the extra outlay has been cheerfully met. Indeed, as Mr. Lawrence says, "no projects, not even proposals for the remission of taxation, have ever been greeted with greater unanimity of approval from the representatives of Indian public opinion." If the irrigational expansion shortly to be completed in tracts of country larger than the whole cultivated area of Egypt is to be successful, it will be largely owing to the skill and rapidity with which cultivators adapt themselves to the new conditions. Herein the Department of Agriculture can play a considerable part. Merely as the "handmaid of irrigation" it will, Mr. Lawrence predicts, justify its existence. In the discussion speeches were delivered by Sir James Monteath, Sir Thomas Holderness, Dr. J. Augustus Voelcker (who sixteen years ago contributed a paper to the Section on the inquiry conducted by him in India for the supreme Government), Lord Reay, Sir George Watt, and Professor Dunstan.

Within the confines of the Indian Empire are upwards of 600 "Native States," which possess territory aggregating nearly 700,000 miles, or a third of the whole of the peninsula, and a population of 66,000,000. At a crowded meeting, presided over by Lord Curzon of Kedleston, Sir David W. K. Barr, in what the Chairman styled a "lucid and illuminating paper," demonstrated the gratifying progress made by the more important of these

States during the past forty years—the term of his career as an official in the "land of the Rajas." In 1868, the group of picturesque and conservative States to be found in Central India and Rajputana were without any railway communication at all; at present the length of the lines in those districts approaches 3,000 miles. In 1870, a distinguished predecessor of Sir David Barr wrote: "The railway will bring light in its train." His prophecy has been fulfilled. The railway, says Sir D. Barr, "has practically changed not only the face of the country, but the character of the people and the attitude of the ruling chiefs." Other influences for good have been the example set by the British rulers (this he places first), the improved standard of administration introduced by British officers temporarily administering certain of the States, and the education of the chiefs, either by private tuition or at the Rajkumar colleges, the Etons and Harrows of India. Amongst other interesting points brought out by the author is the disposition evinced by native rulers to "enter more largely into the federation of the Empire," while still tenaciously adhering to their ancient feudal system. In an eloquent speech Lord Curzon expressed the hope that it would, for reasons to which he alluded, continue to be the policy of the Government of India "to encourage the idea of giving to these young chiefs the best education possible in their own country rather than outside it." He further pointed out that the native chief cannot be left to "rust in his palace with nothing whatever to do," and that one of the foremost duties of the British Government is to find a scope for his energies, his ardour, and his patriotism.

To the much-appreciated series of papers on the provinces and capitals of India, Sir James Digges La Touche contributed one on the United Provinces of Agra and Oudh, previously designated the North-Western Provinces and Oudh, and known to the Mohammedans as Hindustan. Agriculture being the principal industry of the United Provinces and providing subsistence for 70 per cent. of the population, the bulk of Sir James La Touche's admirable paper naturally related to land questions, the author explaining the evolution of the present successful system of assessment, and dealing with such cognate matters as improved methods of revenue collection, co-operative credit societies (an experiment which, it is thought, may have great possibilities), technical education, and famine relief. He attributed the fact that the United Provinces have hitherto escaped the unrest which has agitated Bengal to the superiority of their revenue administration. "In the United Provinces the district officer and his assistants are compelled by their revenue duties to be in close touch with every class of the agricultural community. The Government appears not merely as a tax-collector, but as sharing with its subjects in misfortune, and the district officer is a friend who has earned the trust and confidence of his district and of the natural leaders of the people."

Lord Lamington, in his interesting paper entitled "Reminiscences of Indian Life," touched upon various problems connected with the government of Bombay, and graphically described tours made by him as Governor within the Presidency proper as well as in the outlying province of Sind and the more remote hinterland of Aden. In the discussion both Viscount Midleton and Sir William Lee-Warner referred to the importance of preserving the form of administration peculiar to Madras and Bombay, viz., government by a Board, consisting of a repreentative of the Crown sent out from England, and two councillors belonging to the local service.

The excellent paper contributed by Mr. Richard Burn, I.C.S., on the "New Imperial Gazetteer of India," and read, in the author's absence, by Mr. William Foster, calls attention to an undertaking that had not previously received adequate recognition in this country. The gigantic work, of which the author of the paper is Indian editor and Mr. J. S. Cotton English editor, consists of no less than 26 volumes, or 12 more than the edition in which the memory of the late Sir W. W. Hunter is enshrined, and is, as the Chairman of the meeting, Sir Alfred Lyall, observed, "a great Imperial monument."

Mr. Reginald Gilbert's paper on the attractive subject of Big Game was devoted partly to a vivid description of his observations and adventures as a well-known shikari and practical zoologist, and partly to a full discussion of the further measures needed to prevent the extinction of the more important of the wild animals of India. He suggested *inter alia* that the time has come when the Government should cease to offer rewards for the destruction of tigers and panthers other than "man-eaters."

IV.—Colonial Section.

The recent adoption of the title "Imperial Conference" in place of "Colonial Conference," and the establishment of a separate Dominions Department in Downing-street, made the very able paper in which Mr. A. Berriedale Keith traced step by step the development of Colonial autonomy of special interest. At the outset the author referred to the little noticed fact that the examples of regression to Crown Colony administration are, though of less consequence, quite as numerous as the instances of progress to the system known as Responsible Government. As long ago as 1840 British Guiana, Jamaica, Grenada, Tobago, St. Vincent, Antigua, Dominica, St. Kitts, Nevis, Montserrat, Barbados, Bermuda, the Bahamas and the Virgin Islands had Representative Government. Among the many other points considered by Mr. Keith were the following:—Position of a Governor as a Colonial Officer and as an Imperial Officer; disagreement between the Colonies and the motherland; external affairs, *i.e.*, treaty-making—a matter which has attracted and is attracting much attention in Canada—native rights, &c. Sir Charles Dilke, M.P., who presided, commented seriatim on the more important issues involved, the Agents-General for Victoria and South Australia also taking part in the discussion.

Complementary to Mr. Keith's exhaustive disquisition was the carefully reasoned paper of Mr. Richard Jebb on "The Imperial Problem of Asiatic Immigration," presenting, as it did, a clear, general view of the whole question. The author of "Studies in Colonial Nationalism" argued that the nature of Imperial citizenship must be deduced from the purpose for which the Empire is thought to exist. That purpose he submitted is the promotion and protection of what he terms Nation States. Hence it follows, according to his contention, that no citizen of the Empire has, or ought to have the right to settle in any State of the Empire, "where his presence would be injurious to the national civilisation." Consequently the claim of Asiatics to equal treatment can only be admitted when their numbers are so small that their influence is negligible. He would offer to India as compensation for the exclusion of her people from the "Nation States," a fiscal system similar to that of the self-governing Colonies. The Right Hon. Alfred Lyttelton, M.P., presided, and opened the discussion, the other speakers being Mr. Arthur H. Reid (South Africa), Lord Ampthill, who earnestly urged the Home Government to convene an Imperial Conference for the consideration of this serious question, Sir West Ridgeway and Mr. T. D. Rees, M.P. Mr. Jebb's specially prepared an elaborate summary of the laws and treaties relating to Asiatic immigration, printed as an appendix to the paper, is likely to prove of permanent value.

The Society invited Sir Hanbury Brown, late Inspector-General of Irrigation in Egypt, to read a paper on the work performed in that country under the ægis of England. He was obliged to decline the invitation, partly on the ground that the subject was "too large for a single paper." He, however, consented to contribute a paper on "Irrigation under British Direction," which was read at a crowded meeting presided over by the Earl of Cromer. Confining his very valuable paper to the Delta, Sir Hanbury passed in review the various undertakings by which such enormous benefits have been conferred upon the cultivators of the soil since Sir Colin Scott-Moncrieff on his way home from India in 1883 "was waylaid by Lord Dufferin in the Suez Canal and captured for Egypt." Sir Colin Scott-Moncrieff, Sir Hanbury Brown and their associates have been described by Lord Milner as the "saviours of Egyptian irrigation." Lord Cromer spoke of them as the "saviours of Egypt." They had, he pointed out in an impressive speech, accomplished a task which in one sense is even more remarkable than that of curbing and controlling the refractory waters of the Nile. They have justified Western ideas to Eastern minds. Sir Colin Scott-Moncrieff was present and took part in the exceptionally interesting proceedings.

The subject of the remaining paper was "The Mineral Resources of Western Australia," the author being the Hon. C. H. Rason, Agent-General for that enterprising, progressive, and prosperous colony. The story of the discovery of gold in Western Australia and the development of the mining industry there, sounds, as was remarked, like a fairy tale. Until 23 years ago the precious metal was not found in any appreciable quantity; up to the end of last year the yield has been 750 tons, valued at nearly £80,000,000 sterling, sufficient, Mr. Rason observed, to build and equip a fleet of fifty *Dreadnoughts*. The reduction of the output of 1907, amounting to 27,000 ounces, was explained to be due, among other causes, to cheaper methods of handling making it possible to work formerly unprofit-

able ore. Mr. Rason called attention to an "enormous area of mineral lands" far beyond the power of the present small population to develop thoroughly in the absence of the necessary capital. When the desired mining revival takes place and the new fields referred to are prospected, the results, he believed, "will cause the advancement made hitherto to appear insignificant." The Governor of Western Australia (Admiral Sir Frederick Bedford) who happened to be visiting England at the time, accepted the Society's invitation to preside. His Excellency seemed to share Mr. Rason's optimism, and observed that the paper could not fail to be of great value in making the capabilities of Western Australia better known.

V.—Applied Art Section.

At the first meeting of the Section, on December 17th, Mr. Lewis Day read a paper on "How to make the most of a Museum," the result of practical experience of a large number of Museums of Decorative and Industrial Art abroad and at home, in which he gave his views as to the best arrangements necessary to obtain good results from them. He urged that the instruction of the craftsman and his requirements should be kept in mind as well as those of the mere sight-seer. The Victoria and Albert Museum was the parent of the "Gewerbe Museum," and the world's great indebtedness to it was universally acknowledged. Mr. Day pointed out that, in spite of many differences of opinion, a museum must be accepted as a storehouse, and the galleries therefore were sufficiently decorated by the things exhibited, as other decoration is apt to distract the attention of the visitor. Sir Aston Webb (the Chairman) and other experts fully discussed the many important points raised by the reader of the paper.

Mrs. Hadaway read, at the second meeting, an interesting paper on "Developments in the Art of Jewellery," in which she pointed out how grievously the commercial spirit had obscured the artistic qualities in modern jewellery, and how necessary were the efforts of certain artists to return to the simple methods of the old jewellers, who raised their occupation to the distinct position of one of the fine arts. Mrs. Hadaway specially alluded to the large field to be found in the use of other materials than the precious metals that can be worked with great artistic effect. Some good specimens of modern jewellery were exhibited at the meeting.

At the third meeting, Mr. George Eve read a well-illustrated paper on "Banners in Pageantry," which contained an account of the objects aimed at by the old artists in designing banners, their main object being to produce a picture which would be understood by all who saw it, and for this purpose they designed with clearness and vigour, and paid strict attention to correct heraldry. In modern banners these qualities were usually overlooked, and the painting, which had superseded embroidery, was generally gaudy, and ineffective, If banners were in the future to have the decorative effect they formerly possessed, it would be necessary to return to the principles of the old designers, and to follow their spirit of historical accuracy.

Mr. Cyril Davenport dealt chiefly with the enamel portraits of the sixteenth and seventeenth centuries in his paper on "Enamel Portraits," and showed in the lantern specimens of the work of Léonard Limousin, who copied in enamel the contemporary engravings of Albert Durer and others. He was followed by Jean Petitot, whose work is especially esteemed both in France and England. The fine coloured slides shown by Mr. Davenport exhibited portraits of Louis XIV., Queen Christine of Sweden, Mdme. de La Valliere, Ninon de l'Enclos, Mdme. de Maintenon, and many other courtiers. A remarkable collection of modern enamels by Sir Hubert von Herkomer, Mr. Alexander Fisher (the Chairman), and others, was exhibited. In the discussion, Mr. Day raised the question as to whether enamel, which was more especially within the domain of the jeweller, was suitable for portraiture. The Chairman's answer was that in all such things success justified the treatment and made its own laws.

Miss Isemonger gave in her paper on "Lace as a Modern Industry," on April 28th, a useful account of the various attempts which have been made of late years in different parts of the country to revive English lace-making, an art which had almost died out. A full discussion followed, led by the Chairman (Mr. Alan Cole), in which certain difficulties in the way of the success of the revival, such as the want of fresh artistic designs and the small price received by the workers, which did not offer a proper remuneration for the skill shown by them. An opinion was expressed that it would be desirable if a guild were established to promote the interests of the lace-making industry in England.

VI.—Cantor Lectures.

Arrangements had been made for four courses of Cantor Lectures this year, but the fourth course, by Mr. William Burton, on "The Nature and Structure of the Porcelains," had to be omitted, Mr. Burton, finding himself unable, in consequence of pressure of public work which he had undertaken, to fulfil his engagement. The other three courses were by Mr. Conrad Beck on "The Theory of the Microscope," Mr. H. H. Cunynghame on "Clock Making," and Professor Vivian Lewes on "Fuel and its Future."

Mr. Beck's course consisted of four lectures, which were delivered before Christmas. The Society has had several valuable courses of lectures on the Microscope, notably those by the late Mr. John Mayall in 1886 and in 1888. But the special value of Mr. Beck's course was that it dealt with the most recent developments in the construction of the modern microscope.

Mr. Cunynghame's course consisted of six lectures and was delivered immediately after Christmas. It was both historical and practical, and dealt from first to last with the pendulum, and all the various devices for its control, correction, compensation, and association with the driving mechanism of the clock.

Professor Lewes's course was the third. It dealt with the various fuels, solid, liquid, and gaseous; the fuel supplies of the world; and the methods of utilising fuels, especially coal, to the greatest advantage, the question of high *versus* low temperature carbonisation in the manufacture of illuminating gas being an important part of the last-named problem.

VII.—Juvenile Lectures.

As usual, two Juvenile Lectures were provided during the Christmas holidays. The lecturer was Mr. F. Martin Duncan, and his subject "The Scientific Applications of the Cinematograph." Mr. Duncan, in the course of his efforts to apply photographic methods to biological research, attempted to utilise the cinematograph for such purposes, and has been very successful in overcoming the very great difficulties attendant on the use of the apparatus for microscopic purposes. The principal feature of the lectures was naturally the illustrations—all the work of the lecturer. Cinematographic pictures were shown ranging over practically all departments of animal life, from large mammalia down to insects, and even bacteria. Records were also exhibited showing the circulation of the blood, the rotation of protoplasm in the vegetable cell, and other microscopical wonders. In addition to this, some cinematographic illustrations were given of quarrying granite, blasting rock, and other industrial operations.

VIII.—Howard Lectures.

Under the Will of Thomas Howard (1868) the Society holds a sum of £500 for the purpose of providing prizes or medals for treatises on steam and other sources of motive power, or of rewarding inventors.

In 1884, the Council came to the conclusion that the best way of carrying into effect the wishes of the testator would be to arrange for the delivery under this trust of series of lectures on some subject dealing with motive power, which might, after their delivery, form a text-book on the subject. They have therefore, from time to time, as the accumulated funds permitted, arranged for courses of Howard Lectures, dealing with subjects which seemed to be comprised within the terms of the bequest. Five such courses had already been delivered:—"The Conversion of Heat into Useful Work," by William Anderson, M.Inst.C.E. (1884); "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S. (1893); "The Mechanical Production of Cold," by Prof. J. A. Ewing, F.R.S. (1897); "Polyphase Electric Working," by Alfred C. Eborall, M.I.E.E. (1901); "High Speed Electric Machinery, with special reference to Steam-turbine Machines," by Professor Silvanus P. Thompson, D.Sc., F.R.S. (1906). This Sesssion the Council arranged for a course of three lectures by Dr. H. S. Hele-Shaw, LL.D,, F.R.S., on "The Navigation of the Air," and these were delivered on three successive Thursday evenings in March. The first lecture dealt with the nature of the problem to be solved, while the last two discussed the means by which it was proposed to solve it, first dirigible balloons, and secondly aeroplanes, contrivances in which the force of gravity is opposed dynamically. The course formed a short but brilliant exposition of a subject now attracting much interest, and was greatly appreciated by those who attended.

IX.—Shaw Lectures.

It was mentioned in the last Report of the Council that the Council had determined to devote the surplus funds, which had accumu-

lated under the Benjamin Shaw Trust, to the provision of a course of lectures on Industrial Hygiene. As the subject is one of very wide range, such as would hardly come within the scope of any one individual, application was made to a number of gentlemen who had given special attention to various divisions of the subject, asking them to give single lectures on matters with which they were familiar.

The Council were fortunate in securing promises of help from Dr. Scott Haldane, Dr. Oliver, Mr. William Burton, Mr. W. Garforth, and Miss Adler. Mr. Garforth's lecture on "The Dangers of Coal Dust and their Prevention," for which a date after Easter had originally been allotted, was eventually postponed until the autumn, the reason being that Mr. Garforth expected by that time to have available, as the result of certain experiments which are now being carried out, a much fuller amount of information on certain points than is now accessible. Mr. Garforth's position as President of the Colliery Proprietors' Association of Great Britain, and the long study he has given to the subject, are certain to make his lecture one of considerable importance. The other five lectures were duly given, as proposed.

Dr. Haldane gave two — one on "The Hygiene of Work in Compressed Air (Diving, Caisson Work, Sub-aqueous Tunnelling, &c.)," and one on "The Removal of Dust and Fumes in Factories." Both of these contained the result of much original work, and are well worth the attention of those interested in either branch of the subject. Dr. Oliver's lecture was on "Industrial Poisons—Lead and Phosphorus, with special reference to Lucifer Match Making." Of all the dangerous trades, those involving the use of lead and phosphorus are the most dangerous, and the information contained in Dr. Oliver's lecture should be carefully studied by the public generally, as well as by those industrially connected with the subject. Mr. Burton's lecture on "The Hygiene of the Pottery Trade" was a masterly exposition of the topic. To a certain extent it might have overlapped Dr. Oliver's field, but the latter gentleman had specially excluded the use of lead glaze, and had left it for Mr. Burton, who, as is well known, has long made a special study of the subject. Miss Nettie Adler's lecture on "Child Workers and Wage Earners" was one of very general public interest, and attracted a good deal of attention.

X.—Aldred Lecture.

It is recorded in another paragraph of this Report that the first Aldred Lecture was delivered last autumn by Sir William Ramsay.

The establishment of a series of lectures bearing this title was the outcome of a bequest by Dr. George William Aldred, who, in 1868, left a sum of £100 to the Society of Arts, in order that the interest might provide annually a £5 prize for an essay on some scientific or literary subject. The actual amount of the bequest (£90) was invested in Reduced Three per Cents—£97 16s. 6d. The interest on this was obviously insufficient to provide an annual prize of £5, and the Council consequently determined, in 1883, to allow the money to accumulate until there was sufficient to provide an annual sum of £5. The Council now hope that they may be able to continue the series of Aldred lectures either annually or biennially, as the funds may permit.

The testator died in 1868. He was elected a member of the Society in 1862. He served with Her Majesty's army in India, was an M.D. of Paris, 1841, became a member of the Royal College of Surgeons in 1843, and was made a Fellow in 1859. At the time of his death he was resident in London. He bequeathed nearly all his property amongst public charities, mostly medical.

XI.—Albert Medal.

The Albert Medal of the Society for the present year has been awarded, with the approval of His Royal Highness the President, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S., "For his investigations into the liquefaction of gases and the properties of matter at low temperatures, investigations which have resulted in the production of the lowest temperatures yet reached, the use of vacuum vessels for thermal isolation, and the application of cooled charcoal to the separation of gaseous mixtures and to the production of high vacua."

In making this award the Council have had in view, not so much the wonderful scientific advances which have resulted from the investigations carried on by Sir James Dewar in this country and by his colleagues in other countries, as the industrial applications, actual and potential, rendered possible by the provision of temperatures hitherto unattainable. There are now in existence in Germany and elsewhere industrial plants capable of producing liquid air in very large quantities, and

the fact that as the liquid air gradually rises in temperature its two principal constituents—oxygen and nitrogen—are given off at different temperatures, enables them to be separated and employed for different purposes, the oxygen for the many uses to which it is now applied, and the nitrogen, at all events, for the manufacture of what promises to be an extremely important fertilising agent—calcium cyanamide.

Nor can it be doubted that the possibility of providing on any required scale a medium, which will readily give temperatures 200° C. below the temperature of melting ice, must be capable of important practical applications. It may be admitted that such temperatures are far lower than any which are at present required for industrial purposes, and that the temperatures, which are practically useful, can at present be obtained by simpler and cheaper methods; but it would be no unreasonable prophecy to say that this is not likely to remain true for very long, and that before many years have elapsed the frigorific capacities of liquid air will be utilised by the manufacturer, as they are now being utilised by the scientific investigator. For even now such applications are not lacking. The employment of liquid air, as a source of motive power, to drive compressed air engines, may be regarded as problematical, but it has been used, at all events experimentally, for supplying oxygen in situations cut off from ordinary air supplies, as an explosive, and for some other purposes, besides the important one above-mentioned, the obtainment of oxygen and nitrogen from atmospheric air.

The various applications of low temperatures to scientific research, chemical, physical, electrical, magnetic, and biological, need not here be referred to, though it can hardly be doubted that in due time they will produce their practical and industrial results. It may be noted that no laboratory can now be regarded as completely equipped which does not include amongst its apparatus a plant for the production of liquid air.

An interesting application of Sir James Dewar's researches is the development of the vacuum-jacketted flasks devised by him for preserving liquefied gas, into receptacles for retaining either hot or cold liquids for a long time, without a considerable alteration in their temperature. As Sir James Dewar did not take out any patent for his invention, what appears to be developing into a considerable industry has brought no profit to the inventor, or even to the country, as the manufacture of these appliances is now being carried on by foreigners, but not in England. But it is an important application of scientific invention, and one certainly capable of very considerable development.

XII.—Medals.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1907-8:—

At the Ordinary Meetings:—

To Sir Edward W. Brabrook, C.B., for his paper on "Old Age Pensions."

To Monsieur Lucien Hubert, Député des Ardennes, for his paper on "The Rôle of France in West Africa."

To Mr. C. E. Kenneth Mees, D.Sc., F.C.S., for his paper on "Screen-Plate Colour Photography."

To Mr. Robert Buchanan, for his paper on "The Application of Science to Foundry Work."

To Mr. William Martin, M.A., LL.D., for his paper on "The Law of Treasure Trove."

To Prof. H. S. Hele-Shaw, LL.D., F.R.S., and Mr. Douglas Mackenzie, for their paper on "The Problem of Road Construction with a view to Present and Future Requirements."

To Mr. Ernest R. Matthews, F.R.S.E., Assoc.M.Inst C.E., for his paper on "The Use of Reinforced Concrete in Engineering and Architectural Construction in America."

To Mr. Lovell N. Reddie, for his paper on "The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds."

In the Indian Section:—

To Mr. Henry Staveley Lawrence, I.C.S., for his paper on "Indian Agriculture."

To Sir David W. K. Barr, K.C.S.I., for his paper on "Progress in the Native States of India during the past Forty Years."

To Sir James John Digges La Touche, K.C.S.I., for his paper on "The United Provinces of Agra and Oudh."

In the Colonial Section:—

To Mr. A. Berriedale Keith, M.A., B.C.L., for his paper on "The Development of Colonial Self-Government in the 19th Century."

To Sir Hanbury Brown, K.C.M.G., for his paper on "Irrigation in Egypt under British Direction."

To the Hon. C. H. Rason, for his paper on "The Mineral Resources of Western Australia."

To Mr. Richard Jebb, for his paper on "The Imperial Problem of Asiatic Immigration."

In the Applied Art Section:—

To Mr. Lewis Foreman Day, F.S.A., for his paper on "How to Make the Most of a Museum."

To Mrs. HADAWAY, for her paper on "Developments in the Art of Jewellery."

To Miss ISEMONGER, for her paper on "Lace as a Modern Industry."

Of recent years it has been the practice that no medal should be awarded to readers of papers who had previously received medals from the Society. Acting on this rule the Council were precluded from considering the following papers:—In the Ordinary Meetings the papers by the Hon. Sir John A. Cockburn, K.C.M.G., on "The Franco-British Exhibition, 1908," by Mr. Clayton Beadle on "The Underground Water Supplies of the Thames Basin," and by Mr. John William Gordon on the "Reform of the Patent Law;" in the Applied Art Section the paper by Mr. Cyril Davenport, F.S.A., on "Enamel Portraits."

The Council, however, desire to express their high appreciation of these papers by thanking their authors for them.

The Council have always felt themselves precluded from awarding medals to members of their own body, and they, therefore, could not offer one to Sir William Preece, K.C.B., F.R.S., for his paper on "Technical Education in America." But they had much pleasure in recording their sense of the value of the paper by passing a special vote of thanks to its author.

XIII.—SHAW PRIZE FOR INDUSTRIAL HYGIENE.

In February last, the Council, acting on the report of a committee of judges, awarded the Gold Medal offered by the Society, under the Shaw Trust for Industrial Hygiene, to Professor William Galloway, "In recognition of his valuable researches into the action of coal dust in colliery explosions, the outcome of which researches has been the provision of means by which the risk of such accidents is materially diminished, and a consequent great saving of human life effected."

The Committee having also directed the attention of the Council to the device for "racing" or trueing up grindstones described in the *Journal* of the Society (30th August, 1907), by Messrs. S. R. Bennett and C. F. R. Johnston, the Council decided that this invention, which has for its object the prevention of dust in the process, is worthy of favourable commendation.

Mr. Benjamin Shaw, who died in 1877, presented the Society, in 1876, with a sum of £133, which was to be expended in prizes for inventions for preventing injuries incidental to industrial occupations.

XIV.—OWEN JONES PRIZES.

After the death, in 1874, of Owen Jones, a committee was formed to collect subscriptions for the purpose of founding a memorial, and the balance (a sum of £400) was presented to the Council of the Society of Arts upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes have now been awarded annually since the year 1878 on the results of the annual competition of the Board of Education.

Six prizes were awarded this session, each prize consisting, in accordance with the regulations laid down for the administration of the Trust, of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The list of the successful candidates has already appeared in the *Journal*.*

XV.—MULREADY PRIZE.

After the death of Mulready, in 1863, a fund was formed to establish a memorial to him. Sir Henry Cole was treasurer of this fund. The greater part of it was expended in erecting a monument over Mulready's grave in Kensal-green Cemetery. This monument is in the charge of the Society, and from time to time small sums have been expended on its cleaning and restoration. The balance, £109, was presented to the Society of Arts with the view of a Mulready Medal being presented occasionally to the student who should exhibit the best drawing from the nude at the annual examinations of the Education Department.

The Medal has been awarded on several occasions, the last occasion being in 1903. In April, 1907, it was announced in the *Journal*† that a gold medal, or a prize of £20, would be offered for competition among students of Schools of Art in the United Kingdom, at the annual competition of the present year.

As soon as the report of the Examiners is

* See *Journal*, vol. lv., p. 1021, 20 Sept., 1907.

† See *Journal*, vol. lv., p. 575, April 12th, 1907.

received by the Council, the result of the competition will be announced in the *Journal.*

XVI.—Stock Prize.

In 1871 John Stock left £100 Consols to the Society, with the condition that the interest should be applied for the promotion of drawing, sculpture, and architecture. From time to time, as the accumulated funds permitted, prizes have been awarded under the Trust. In 1893 and again in 1897 prizes were offered to students in Schools of Art for architectural designs. A Gold Medal, or a prize of £20, was again offered for competition among the students of the Schools of Art at the annual competition of the present year for a design for an architectural decoration*.

The results of the competition, as soon as decided, will be published in the *Journal.*

XVII.—North London Exhibition Trust.

In 1865 the Committee of the North London Working Classes and Industrial Exhibition (1864) presented to the Society a sum of £157, the balance of the surplus from that Exhibition, with a view to the award annually of prizes for the best specimens of skilled workmanship exhibited at the Art Workmanship Competitions of the Society. The Art Workmanship Competitions were discontinued after 1870, but since that date various prizes have been awarded under this Trust. In 1903 it was found that the funds had accumulated, and accordingly it was determined to make a special offer of prizes of the value of Fourteen Guineas to the students of the Artistic Crafts Department of the Northampton Institute, Clerkenwell. These prizes have been continued annually to the present time. The results of the award for last year were announced in the *Journal* last December.† As the accumulation is now nearly exhausted, the Governing Body of the Institute were offered the choice between annual prizes of smaller value, and occasional prizes of the amount above mentioned. They selected the former, and therefore a sum of £5 will be annually devoted to the purpose until further notice. Prizes of that value, have, accordingly been offered for the current year.

* See *Journal*, vol. lv., p. 575, April 12th, 1907.

† See *Journal* for Dec 23, 1907, vol. lv., p. 63.

XVIII.—Fothergill Prize.

It was announced in the last report of the Council (June, 1907) that they had resolved to offer under the Fothergill Trust, a Gold Medal, or a prize of £20, for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious, the object being to encourage the production of a rescue apparatus which would enable a succouring party to reach men cut off—in case of mining accidents—by irrespirable gases, or suffocated by them. Many such appliances exist, but it does not appear to have been decided which of them are the best, or even which are of practical use.

In response to the announcement in the *Journal** a number of appliances were submitted by the specified date, March 31st last, and the Council have appointed a Committee to deal with them. Inasmuch however, as it is intended that all the apparatus sent in shall be submitted to practical trials it is certain that some time must elapse before any decision as to their merits can be arrived at.

XIX.—Swiney Prize.

The next award of the Swiney prize will be in January, 1909, the sixty-fifth anniversary of the testator's death. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup, value £100, and money to the same amount; the award is made jointly by the Royal Society of Arts and the College of Physicians. This cup is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A.

In accordance with the arrangement with the College of Physicians, the award next year will be for Medical Jurisprudence.

Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter addressed to the Secretary of the Society.†

XX.—Prizes for Drawing.

Since 1889, the Council have annually placed at the disposal of the Royal Drawing Society, for competition among the candidates at its

* See *Journal*, p. 802, vol. lv., June 21, 1907.

† A list of the recipients will be found in the *Journal* for March 13, 1908, vol. lvi., p. 413.

annual examination, 12 Bronze Medals, and these medals were awarded for drawings sent in by students to the exhibition held by the Drawing Society in April last.

XXI.—Examinations.

At one time it was the practice to include in the Annual Report a full report of the results of the Examinations. The number of candidates entering for the Society's examinations is now so large, and the additional work involved by the addition of the Advanced Stage so considerable, that this is not now possible. A separate supplementary report on the examination of 1907 was published in the *Journal* of November 15th last after the results of the three stages had all been issued, and it is proposed to follow the same plan for this year. The Results of Stage III., Advanced, were published on June 18th. It is hoped to publish the results of Stage II., Intermediate, during July; and of Stage I., Elementary, early in August.

The total number of papers worked was 25,804, the number last year being 24,569. These were divided among the various Stages as follows: — Stage I., 9,810; Stage II., 11,199; Stage III., 4,795. The corresponding figures for 1907 were—Stage I., 8,952; Stage II., 10,802; Stage III., 4,815. It will be seen therefore that there was a slight increase in Stages I. and II., and a decrease in Stage III.

It may be interesting to note that from 1883, when the present system of Examinations was introduced, down to and including 1907, 212,800 papers have been worked in the Society's Examinations. On these 149,748 certificates were granted, and there were 63,052 failures.

The Council have to record, with much regret, the sudden death of Mr. Naftel, who has acted as Examiner in French since 1905, and conducted all the colloquial examinations in French since their establishment in 1902.

XXII.—Viva Voce Examinations in Modern Languages.

Up to the present date 16 examinations have been held this year in London, Guernsey, Hitchin, and Manchester. Arrangements have also been made for holding examinations at several other centres.

At these examinations 343 candidates presented themselves, of whom 271 passed (90 with distinction) and 72 failed. The languages taken up were French, German, Italian, and Spanish.

The results of previous years are as follows:—

Year.	Number Examined.	Passed.	Failed.
1902	280	202	78
1903	456	324	132
1904	540	375	165
1905	681	502	179
1906	644	469	175
1907	629	476	153

These examinations are held at any of the Society's centres where the necessary arrangements can be made. They are held at any date convenient to the local committee. The examination includes dictation, reading, and conversation, and the examination is so arranged as to test efficiency in a colloquial knowledge of the language, without laying too much stress on minute grammatical accuracy. Candidates who are reported upon as highly qualified by the examiners, receive a certificate of having passed with distinction.

The examiners are Mr. S. Barlet (since Mr. Naftel's death) for French, Professor H. G. Atkins for German, Professor Ramirez for Spanish, and Mr. Luigi Ricci for Italian.

The numbers this year, when all the examinations are finished, are not likely to show any considerable increase on 1907.

XXIII.—Practical Examinations in Music, 1907.

The practical examinations in Music were not concluded last year until the 10th July, too late for the results to be included in the Report of the Council. They lasted for 12 days.

The examination was conducted by Dr. Ernest Walker, M.A., and Mr. Burnham Horner.

The system of examination was the same as that for recent years. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play or sing a piece, or portion of a piece, at sight, and to play certain scales.

In all, 466 candidates entered, and of these 457 were examined, a decrease of 10 as compared with the previous year. There were 371 passes and 86 failures.

The following were the subjects taken up:—Piano, singing, violin, violoncello, viola, and

bassoon. 371 entered for the piano, 292 of whom passed; 67 entered for the violin, of whom 61 passed; 5 entered for the violoncello, of whom 4 passed; 12 entered for singing, all of whom passed; one entered and passed for the viola, and one for the bassoon. One medal was awarded.

XXIV.—Practical Examinations in Music, 1908.

The Practical Examinations for the present year have not yet been concluded. They commenced on Tuesday, June 23rd. They will be finished on July 4th, after which a summary of the results will be given in the *Journal*. The work of the examination is being carried out by the same examiners as in the last seven years. 439 candidates have entered for the present examinations, a decrease on last year of 26.

These examinations were proposed in 1876 by Dr. Hullah, and were first established in 1879. Dr. Hullah acted as Examiner from 1879 till his death in 1884. He was succeeded by Mr. W. A. Barrett, who had for some time previously acted as his assistant in these examinations as well as in his official work. Mr. Barrett carried the work on till 1891, when he died. Sir John Stainer was appointed Examiner in 1892 conjointly with Mr. W. G. McNaught, but after serving for one year he was succeeded by Sir Joseph Barnby, who held the post till 1894 in conjunction with Mr. McNaught. In 1895 Mr. John Farmer was appointed, and he continued to act till 1899. Mr. Ernest Walker and Mr. Burnham Horner were appointed Assistant Examiners in 1895, at Mr. Farmer's request, and they acted as Examiners from 1900 to the present year.

In the first year of these examinations—1879—117 candidates were examined. This number increased gradually and intermittently to 276 in 1891, and to 395 in 1895. In 1896 certain changes in the system were introduced. No alterations have since been made. In 1896 there were 376 candidates; the numbers rose gradually to 566 in 1900, and reached 576 in 1904. Since then there has been a gradual decline to the number above stated (439) for the present year.

XXV.—Deterioration of Paper.

In 1898 a Committee of the Society reported on the question of the deterioration of paper. This report was not without its effect at the time, but still there has been but little, if any, improvement in the character of the paper generally used for documents and books of value.

A large proportion of books are still being produced on perishable papers. This, as mentioned last year, is due more particularly to the growing popularity of photographic reproductions, and the necessity of adapting papers to the requirements of the "process" block, and the dominant demand for cheapness.

The chief offender is the imitation art paper, heavily loaded with clay, and calendered so as to produce surface at the expense of the substance of the paper.

With the object of again drawing public attention to the question, the Council therefore re-appointed the Committee. It is now engaged in the collection of information, but is not yet in a position to make any report.

XXVI.—Honorary Royal Members.

The Society has to deplore the loss of two members, who added lustre to its list, H.M. the King of Sweden, who had been an Honorary Royal Member for over thirty years, and H.M. the King of Portugal, who was elected two years ago, in 1906.

H.I.M. the German Emperor, on the occasion of His Majesty's visit to this country, in November last, graciously accepted the invitation of the Council (conveyed through H.R.H. the President) to permit his name to be added to the list of the Society's Honorary Royal Members.

Besides the German Emperor, the list of Honorary Royal Members now includes the King of the Belgians (1876), the King of Denmark (1907), the King of the Hellenes (1906), the King of Norway (1906), and the King of Spain (1905).

XXVII.—Conversazione.

The Annual Conversazione of the Society for 1907 was held for the eighth year in succession at the Gardens of the Royal Botanic Society. For the first time since the Conversazione has been held in the Gardens, it was not favoured by the weather, and, consequently, was rather less successful than its predecessors. The Conversazione this year is to be held, by permission of the Trustees of the British Museum, at the Natural History Museum, South Kensington, on the 2nd of next month.

XXVIII.—New Council.

The Vice-Presidents retiring by seniority this year are Lord Blyth, Lord Curzon, Sir Charles Hartley, and Sir William Preece. Sir Owen Roberts also retires from the office of Vice-President in order that he may offer himself for the position of Treasurer, a position he has held on several occasions much to the advantage of the Society. To fill the vacancies thus created, the Council propose Lord Cromer, Sir William White, Sir Boverton Redwood, Sir Charles Kennedy, and Sir George Birdwood. Lord Cromer, who was elected a member in 1903, and last year received the Albert Medal, has not previously been on the Council. Sir George Birdwood retires from the office of Treasurer, and Sir Boverton Redwood has served his time as an Ordinary Member of Council. Sir William White and Sir Charles Kennedy have both in previous years been on the Council.

The retiring Members of Council are Sir Boverton Redwood, as above mentioned, the Hon. H. C. Parsons, Mr. W. Knight Clowes, and Mr. Arthur Claudet. To fill their places the Council recommend Mr. Lewis Foreman Day, who, as the Members are aware, is an old member of the Council, has laboured energetically as a member of the Committee of the Applied Art Section, and has given the Society several courses of Cantor Lectures and papers, Sir Thomas Holdich, who also has previously served, and Sir George Gibb and Colonel Sir Colin Scott-Moncrieff, who have not before been on the Council.

XXIX.—Obituary.

The Society has suffered rather severely by the deaths of many eminent Members during the past year. The loss of its two distinguished Honorary Royal Members, His Majesty the King of Sweden and His Majesty the King of Portugal, is referred to in another portion of the Report.

Among its ordinary members who have died, the most eminent was Lord Kelvin—at the time of his death, the greatest among the scientific men of this, or any other, country. He became a member of the Society in 1880, received the Albert Medal in 1879, was Vice-President from 1893-96, and from 1903 to the time of his death. In 1881 he read a paper on Lighthouse Characteristics. Another recipient of the Albert Medal who has died since the last Report of the Council, was Sir William Perkin. The Medal was given to him in 1890. He became a member in 1868, and served on the Council from 1877 to 1882. In 1868 he gave the Society three Cantor Lectures on the Coal Tar Colours, and in 1879 two lectures before the Chemical Section on Alizarin. Another past Member of the Council was Sir John Evans, who joined the Society as far back as 1860. He was a Vice-President from 1898 to 1901, and Chairman for the Session 1900-1901.

Sir Charles Turner was an active member of the Indian Section Committee, and took part on several occasions in its proceedings. Mr. John Sparkes was a frequent attendant at the Society's meetings, joining in the discussions, and taking the chair on several occasions. He read two papers—one in 1874, and one in 1880—on "Lambeth Stoneware." Sir John Crease read a paper on "Ceuta and Gibraltar," in 1902. Dr. Dupré, who had for many years been Chemical Adviser to the Home Office, took an occasional part in the Society's discussions. Mr. A. G. Stanton read two papers on Tea — one in 1895, and the second in 1904. Sir William Phillips Sawyer, who had been Clerk to the Drapers' Company for many years, was a Member of the Society since 1881, and though he never took any active part in its work, the Society was indebted to his influence for much valuable aid received from the Drapers' Company. Mr. W. A. Hepburn, the Clerk to the Leathersellers' Company, was associated with the work of the Society's Committee on Leather for Bookbinding, since it was owing to the liberality of the Company that the Society was able to produce the rather costly illustrated edition of the Report of that Committee. Mr. Alfred Bache, who was Secretary of the Institution of Mechanical Engineers up to 1898, was a Member of the Society from 1877. Mr. Thomas Forster Brown read the Society a paper on "Our Coal Supplies," a subject on which he was a very great authority, in 1899. Mr. R. A. Thompson, for many years Assistant Director of South Kensington Museum, was one of the oldest members of the Society at the time of his death, since he became a member as far back as 1857. Though he never took any actual part in the work of the Society, he always felt a warm interest in its welfare, and his relations with its executive were most friendly. The Earl of Clanwilliam had been a member of the Society since 1891, and Mr. John Pritchit since 1870. Amongst other members of the Society who died during the past year may be mentioned the Right Hon. Evelyn

Ashley, Colonel Swan, Dr. Alexander Herschel, Mr. B. Warner, Mr. C. E. Layton, and Mr. G. M. Arnold.

XXX.—Finance.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the Assets and Liabilities of the Society, its Investments and the Trusts standing in its name.

The Council have been able to provide, out of the revenue of the year, a sum of about £500 for the renovation of the decorations of the Meeting-room, Library, &c.

The Chairman, in moving the adoption of the Report, referred to the fact that this was the last occasion on which he would have the honour of presiding as Chairman of the Council, and he wished to thank the members of Council for the very kind manner in which he had been treated during his term of office. The privilege of following in the footsteps of the distinguished men who had held the same office in past years was an honour which he very greatly appreciated. As regards the Report itself, he thought the principal incident this year was the honour conferred upon the Society by His Majesty in permitting it to use the term "Royal." There was one thing not mentioned in this year's Report, which he should like to have seen settled, and that was the question of the Society's House. The Society badly needed more accommodation, but the Council had never been able to see their way clear to providing it, and the matter would have to be dealt with by his successors in office. He thought it was satisfactory that the Society had been able to defray the cost of the renovation of the decorations of the Meeting-room, &c., out of the ordinary income of the year, instead of having to charge it to the capital account. He laid stress on the educational work which the Society was able to do by means of the Trust Funds, and did not think the Society could be more usefully employed than it was. The lectures and papers read before the Society were all given by men who were experts of high standing, and he thought that anybody who attended the meetings, or read the reports of the proceedings in the *Journal*, was able to keep himself in touch with subjects dealing with the most recent developments of Science and Industry, and that at the end of the session he would certainly know a great deal more than he did at the beginning. He hoped the Society would be able to secure similar papers to Monsieur Hubert's from other distinguished Frenchmen, as he felt sure it would be a great advantage to both nations. In conclusion, he said the Society was really doing great and important work, and that it ought to be, as he thought it was, appreciated by the public.

Sir William Abney, K.C.B., D.Sc., F.R.S., seconded the adoption of the Report.

The adoption of the Report was then agreed to.

The Chairman, in complimentary terms, moved a cordial vote of thanks to Sir Henry Trueman Wood (the Secretary), Mr. Henry B. Wheatley (the Assistant Secretary), Mr. Samuel Digby, C.I.E. (Secretary of the Indian and Colonial Sections), Mr. George Davenport (the Chief Clerk), Mr. Buchanan (the Accountant), and the other officers of the Society. He said he need scarcely tell the Members with what thorough agreement and pleasure he did so. He also, in the name of the Society, congratulated Mr. Digby on the honour which His Majesty had conferred upon him last year. Mr. Digby, he said, had been most industrious and energetic, and the results of his work in the Indian and Colonial Sections had been of the very highest value.

The Secretary, in returning thanks, endorsed what the Chairman had said with regard to the extremely valuable work which Mr. Digby had rendered the Society in connection with his Sections.

The ballot having remained open for one hour, and the Scrutineers having reported, the Chairman declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

President.

H.R.H. The Prince of Wales, K.G.

Vice-Presidents.

H.R.H. The Duke of Connaught and Strathearn, K.G.
Duke of Abercorn, K.G., C.B.
Sir William Abney, K.C.B., D.C.L., D.Sc., F.R.S.
The Lord Chief Justice, G.C.M.G.
Sir Steuart Colvin Bayley, K.C.S.I., C.I.E.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Sir William Bousfield, M.A., LL.D.
Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.
Sir William Crookes, D.Sc., F.R.S.
Francis Elgar, LL.D., F.R.S.
Hon. Sir Charles W. Fremantle, K.C.B.
Robert Kaye Gray.
Colonel H. C. L. Holden, R.A., F.R.S.
Sir Charles Malcolm Kennedy, K.C.M.G., C.B.
Sir William Thomas Lewis, Bart.

Sir Philip Magnus, M.P.
Sir Westby B. Perceval, K.C.M.G.
Sir Boverton Redwood, D.Sc., F.R.S.E.
Alexander Siemens.
Carmichael Thomas.
Sir Aston Webb, R.A.
Sir William White, K.C.B., F.R.S., LL.D., D.Sc.
Sir John Wolfe-Barry, K.C.B., F.R.S.

ORDINARY MEMBERS OF COUNCIL.

Thomas Jewell Bennett, C.I.E.
Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.
Michael Carteighe, F.O.S.
Henry Hardinge Cunynghame, C.B.
Lewis Foreman Day.
Sir George S. Gibb.
Henry Graham Harris.
Colonel Sir Thomas Hungerford Holdich, R.E., K C.M.G., K.C.I.E., C.B.
Sir John Cameron Lamb, C.B., C.M.G.
Sir William Lee-Warner, K.C.S.I.
Colonel Sir Colin Campbell Scott-Moncrieff, K.C.S.I., K.C.M.G.
Sir William Hood Treacher, K.C.M.G.

TREASURERS.

Prof. John Millar Thomson, LL.D., F.R.S.
Sir Owen Roberts, M.A., D.C.L., F.S.A.

SECRETARY.

Sir Henry Trueman Wood, M.A.

On the motion of the CHAIRMAN, a vote of thanks to the Scrutineers was carried unanimously.

Sir WILLIAM ABNEY, K.C.B., D.Sc., F.R.S., as a Past-Chairman of Council, proposed a hearty vote of thanks to Sir Steuart Colvin Bayley for the able way in which he had conducted the affairs of the Society as Chairman of Council during the past year. He need scarcely say that Sir Steuart had followed the traditions of his predecessors in maintaining the dignity of the chair, and had given the greatest attention to the business which had come before him as Chairman of the Council.

The motion was seconded by Sir BOVERTON REDWOOD, D.Sc., F.R.S.E., who thought that it was only those who were privileged to be associated with the Chairman in the routine work of the Society, who could fully appreciate all that Sir Steuart had so successfully done in the interests of the Society. The motion having been carried unanimously,

The CHAIRMAN acknowledged the vote of thanks.

The meeting then adjourned.

HONEY IN CALIFORNIA.

In his report on the trade and commerce of the States of California, Nevada, and Utah, and the territory of Arizona, just issued (Annual Series, No. 3998), Mr. Consul-General Hearn has some interesting references to the honey yield of California. It was predicted during last summer that the output of the year would be very small, but in fact it was almost double that of 1906, the total being estimated at 8,700,000 lbs. That bee keepers in the State consider 100 to 300 hives sufficient for any one farm. The honey gathering is usually from April to September, depending upon the weather and the length of the blooming period of the bee forage. The extracting season commences in May or June and is usually about six or eight weeks in duration. In a good season California produces about 4,500 tons of honey. Much of this is the famous mountain sage honey, which is water-white, and is said to be the mildest flavoured honey in the world. In the northern part of California bees gather their stores from the bloom of the carpet grass and the eucalyptus; in the central countries from alpalpa and orange blooms, white, black, and purple sage, *rosa amoria*, sumac, and wild buck wheat. The last two give a poor grade of sweet, which is usually extracted to be used for winter feeding, or, these later stores are left to the hives, if the blooming season comes when the combs are full.

The method of honey extracting, as described by Mr. Consul-General Hearn, is interesting. Details vary in different apiaries, but in one called the Model Apiary, the process is as follows:—With a hand-car, or small truck, the apiarist stops beside a laden hive; this hive is two stories, sometimes three. With a thin-bladed knife he loosens one edge of the lid, and thrusts the mouth of the smoker beneath it. With quick pressure of the bellows he sends the smoke into the chamber, and the bees hurry below to avoid suffocation. He lifts the combs, and brushes away the stupefied bees. If the honey is capped over, or partially so, he puts the comb into wooden-handled baskets made for the purpose, and when he has a load the car is pushed to the extracting house, to which it runs on a miniatuie railway, which runs its cars through every street of the bee city.

Well filled comb-hives weigh 8 to 12 lbs., according to thickness of the comb, and specific gravity of the honey. Inside the extracting house, is a deep, tin-lined, uncapping box occupying nearly the whole side of the room, and in this box the frames are suspended until wanted. Uncapping is largely done by women. The frame, containing the comb, is balanced on one edge of the uncapping box, and a long knife dexterously slices off a thin sheet of wax, thus destroying the cell seals. As the combs are uncapped they are placed in the baskets of the contractor, which are reversible, and the honey is thrown out by centrifugal force. From the bottom of the extractor runs a 3-inch pipe on a gentle incline to a tank outside the extracting house. This tank holds

several thousand pounds. Across the opening of the pipe where it leaves the extractor is fastened a section of wire netting with rather coarse meshes to keep pieces of comb or refuse from passing into it.

In the top of the receiving-tank is suspended a white flannel bag, 2 feet in length, in the upper part of which is run an iron hoop some 1 foot 3 inches in diameter, which first fits the opening in the tank; this further strains the honey. The honey is then drawn into tin cans, holding from 12 to 60 lbs. each.

THE MEXICAN COTTON INDUSTRY.

The principal cotton-growing district of Mexico is comprised in what is known as the "Laguna district," which includes the southern portion of the States of Chihuahua, Coahuilo, Nuevo Leon, Tamaulipas, Durango, Yacatecas, and San Luis Potosi. In this district is produced probably 85 per cent. of the cotton grown in the country. Great efforts have been made to increase the acreage under cultivation, but such efforts have not resulted successfully. According to authorities familiar with the cotton-growing industry in Mexico, this is accounted for by various and conflicting reasons. It is claimed that the Laguna district is at present turning out about all the cotton it can produce. Again, it is claimed that the land is held in large tracts, and that the small cotton grower cannot secure small areas for planting, while the larger growers do not enter into it to any great extent, except in the State of Coahuilo. The cotton district is an irrigation country, and it is stated that at the present time all Government water concessions are taken up, which is another obstacle to would-be growers. There are other parts of the Republic well suited to cotton growing, such as the States of Chiapas, Vera Cruz, Purbla, and Morelos, and the coast lands of the States of Oaxaca and Guerrero. According to the Special Agent in Mexico of the United States Government, the country does not produce sufficient cotton for home consumption; in fact, it may be estimated that the production of the staple in Mexico yields about one-half the amount required for use in her industries. Mexico imports annually a small quantity of Egyptian cotton for use in various ways. The exports of cotton from the United States to Mexico in 1907 were valued at £8,000, as compared with £325,000 in 1906, this noticeable falling off being largely due to the unusually favourable yields of the home-grown staple. The experimental growth of the Caravonica cotton, a staple of unusual length and quality, especially adapted to tropical localities, has recently been successfully undertaken in the State of Vera Cruz. It is impossible at the present time to secure accurate official statistics of the acreage now under cotton cultivation in Mexico. The best cotton authorities, however, estimate the area for 1907 planted in cotton to have been 250,000 acres. Cotton is planted in Mexico in March; the season of growth extends from March until June, and picking takes place from June until September. No fertilisers are used in the cultivation of the plant, although the consideration of their adoption is receiving the attention of the growers. The fibre of the Mexican cotton is of good length and strength, thinner however than that of American cotton, less silky, and not so clean. The plant suffers from many pests, among which are the boll weevil, which is said to have been known in Mexico fifty years before it was found in Texas, and is supposed to have migrated thither. The "conchuela" is perhaps the most common pest, and of diseases common to the cotton plant, viruela, or cotton small pox, is prevalent and annually destroys large quantities of cotton. Mexican cotton is baled according to improved methods. The presses used are heavy, and the cotton is baled under pressure of from 3,000 to 4,000 pounds. There are no central presses in Mexico to receive the cotton from various gins. Each plantation has its own gin and press. According to the latest complete annual industrial statistics, the cotton industry of Mexico in the fiscal year 1905, employed 30,162 persons, working 678,058 spindles, and 22,021 looms, and consumed 68,850,195 pounds of cotton in 128 factories, during the year. It is said that the increase in cotton manufacturing plants in Mexico since that period has been limited. By far the larger number of factories are situated in the central States, Puebla leading with 29 mills, in which are worked 113,000 spindles. The State of Vera Cruz contains 11 mills, and the most important manufacturing company is found at Orizaba, which is said to own about one-fifth of the total cotton manufacturing outfit of the Republic. The mills of Orizaba are modern, up-to-date plants, complete in every detail — one of them is said to be one of the largest in the world—and of a size which will compare favourably with the cotton establishments in the United States. A large proportion of the raw cotton produced in Mexico is consumed in the mills at Orizaba. The quality of the Mexican cotton goods output is constantly improving. The output includes cotton sheetings—bleached and unbleached, tickings, linings, drills, mezclillo (a mixed gray cloth), shirtings, printed percales, quilts, cotton napkins, tablecloths, handkerchiefs, and cloths of mixed woollen and cotton. Knitted garments and fleece-lined underwear are manufactured, although this industry is in its infancy. Many manufactories exist in various districts of Mexico, where the cotton-seed is used; the chief products of which are soap, glycerine, cotton-seed oil, cotton-seed meal, and cotton-seed meal cakes. The cotton-seed meal is used, as in other countries, as a food for fattening stock for market. At Gomez Palacio, in the State of Durango, is situated the largest factory using cotton-seed in Mexico; soap, glycerine, and cotton-seed oil being manufactured in large quantities. Such factories, of more or less importance, are found in many parts of Mexico, and the rapidly growing industry is fast becoming a prominent one.

HOME INDUSTRIES.

The Meat Trade.—One of the many consequences of the financial panic in the United States last year is the serious rise in the price of beef. In the autumn of 1907, American farmers sold their stock at any price rather than spend their money in buying feeding stuffs to keep their cattle through the winter. The result is that they have now barely enough for their home trade. From January to June of this year the total imports of American beef into this country were 672,615 cwt. as against 1,135,762 cwt. for the corresponding period of last year. Then the decrease in the imports of Canadian meat amount to 18,859 cwt., consequent upon the depletion of stocks, due to the extraordinaiy severe winter of two years ago. Of the total imports of meat which passed Smithfield last year not less than 41 per cent. came from North and South America. Fortunately the imports from South America not only show no decrease this year, but have actually increased by 150,425 cwt. Deduct this from the shrinkage from other sources of 482,006 cwt. and there is a shortage of 331,581 cwt. A good deal has been said recently about the American "Beef Trust," and it is alleged that the Trust is buying up the chilling establishments in Argentina, and that when it has acquired the principal ones it will control the market. The Trust, it is said, has already acquired a considerable number of stalls at Smithfield, and dominates that market. But there is ample explanation of the rise in the price of beef, in the figures quoted above. It is a question of supply and demand. The demand grows year by year in consequence of the growth of population, and the stationary character of the home production, but the present supply is very short, and, as a necessary consequence, prices have gone up. Reports from the United States point to a good grass-growing year, so that in the autumn larger exports are probable, and we may see prices lower. As it is, the rise is confined to beef.

The Electrical Industry.—About £40,000,000 is invested in the United Kingdom in works for the manufacture of generators, motors, switch-gear and accessories, but hitherto there has been a very inadequate return upon this large capital. There are some 300 companies engaged in the business, but not many of them are making satisfactory profits. What is the explanation? The tardy start in the manufacture of electrical appliances placed this country at great disadvantage as compared with Germany and the United States, and the cutthroat competition of the foreigner continues the depression. German motors of excellent make are sold in England at rates unapproachable by British manufacturers who seek a fair profit. The present position of the electrical manufacturing industry in Great Britain is the penalty that is being paid for the throttling due to the Electric Lighting Act of 1882, and it is to be feared that the time is still somewhat distant when British electrical machinery will be able fully to hold its own against the foreigner.

Sida.—There has been some talk of the necessity of a flax substitute, and in this connection the Director-General of Commercial Intelligence of India is trying to ascertain and make known the commercial value of sida in the United Kingdom. It is a vegetable fibre found in India, but hitherto little attention has been given to it, although it has been under observation for commercial purposes at one time or another for the last sixty years. Jute is almost a monopoly of Bengal, where it is grown in rotation each year with rice, and the cultivator is not likely to give time and attention to the production of sida, but an attempt to cultivate it may be expected in Southern India and the Bombay Presidency. Sida resembles jute in structure and chemical characteristics, but is more uniform, clearer, and softer in touch. An important factor in its component parts is a relatively high percentage of cellulose—83 per cent. as compared with 75 per cent. in the case of jute. It is not much more than seventy years since the value of jute for textile purposes was first fully recognised in the United Kingdom. It had been frequently tested, but after being forcibly rejected in London was taken up by a group of Dundee merchants and manufacturers.

The Home Arts and Industries Exhibition.—The Home Arts and Industries Association is to be congratulated upon the success of its exhibition held at the Horticultural-hall last week. The attendance was large, and the exhibition of great interest. There was good work from Mrs. Watt's Guild at Compton (Surrey) in clay modelling. An iron grill copied from a model in the British Museum by the Sarum Wrought Iron Works, Salisbury, was a beautiful piece of workmanship, and won the silver cross. There was brass work, and basketwork, and weaving, lace-making, silver work, wood-carving, glove-knitting, quilting, smocking, and pottery. It has been asked how far this revival of the village arts is reacting on the homes of the villagers? Whether men who have learnt to use their hands at iron work are moved to work on the fittings of their own homes, or clay-modellers to work portraits of their families, or ornaments for their own shelves and gardens? It is an interesting point, and the data are wanting. Lack of means to buy material is a difficulty in the way, but exhibitions like that at the Horticultural-hall can hardly fail to give an impetus to village talent, and this is all to the good.

Cotton Seed.—Not to speak of others, there is one industry in which England has been unable to hold her own. Commercially the cotton-seed oil industry had its origin in England, and twenty-five years ago England was the leading cotton-seed oil producing country in the world. But according to a report just issued by the United States Census Bureau the

number of cotton-seed oil mills in the United States is now 786 against 25 in Great Britain. The growth of the industry in the United States is not surprising, being due to natural causes. The liability of cotton seed to heat and deterioration in storage and in transit has led to the establishment of oil mills as near as possible to the source of seed supply. The considerations of freight and of local demand for the by-products of the industry are important factors. For these reasons the industry is beginning to grow in India and Egypt as well as in the United States. Last year in the United States 175,724,840 gallons of cotton-seed oil were produced, and 1,785,804 tons of cotton-seed cake and meal.

The Wool Trade.—The indications point to better prices for all kinds of wools. Dealers and top-makers are unwilling to part with their stocks at present quotations and farmers who can hold are of the same mind. The grower cannot, it may be thought, run much risk in holding for better prices, for these home-grown wools at the moment are unfashionable, and dealers are refusing to give half the price which the grower got a couple of years ago. Cablegrams report good rains throughout South Australia, most of Victoria and the Riverina and other parts of New South Wales. The resulting green grass must have a very favourable effect on the lambing.

The Heaviest Ship Afloat.—The statement that has appeared in various newspapers to the effect that the Holland-Amerika steamship *Rotterdam*, just finished by Messrs. Harland and Wolff, is the heaviest ship afloat, is strangely incorrect. The *Rotterdam* is 677 feet long, 78 feet wide, 56 feet deep, with a gross tonnage of 25,000 tons. Her displacement when deep laden will, it is said, be about 40,000 tons, and her carrying capacity (dead weight) is 20,000 tons. These figures assume, no doubt, that the vessel is laden down to the maximum draught permitted, probably 37 feet to 38 feet. But the *Lusitania* and the *Mauretania* are 760 feet long, 58 feet broad, and over 60 feet deep, with a gross tonnage of about 33,000 tons, and a displacement of about 38,000 tons at 34 feet draught of water. If these vessels were laden to a draught of 37 feet to 38 feet, their displacement would be a good deal over 40,000 tons. Their engine power is about four times as great as that of the *Rotterdam*, their speed eight knots greater, and in their lightest condition they average very nearly 30,000 tons, or about half as much again as the *Rotterdam* in the same condition.

Trade Marks in Turkey.—Considerable irritation has been caused by the action of certain traders in Turkey, who have discovered that under the Turkish trade-mark regulations issued in 1888 they can obtain registration of marks to the exclusion of other traders, notwithstanding that such marks are, according to British recognition of proprietary rights, incapable of appropriation, and, therefore, unrecognisable, or are, in the judgment of the commercial world generally, the property of other people. The misappropriation complained of is the forging of marks which in Great Britain are common property. There are in the cotton trade many common marks, common because they are incapable of registration, since they are, and have been for a long time, used by many persons in common. The situation developing in Turkey is both annoying and prejudicial to British trade. The Turkish regulations afford no relief. They concern themselves simply with the rights of the registered owner, and the only appeal is to a Turkish Court knowing nothing of trade-mark law. Moreover, the expenses incurred in such an appeal must be heavy, and the applicant would be bearing the brunt of a battle for a common mark, so that success would give no exclusive advantage. Probably the Foreign Office will be asked to move in the matter, to induce the Turkish authorities to postpone registration of trade marks until they have satisfied themselves that the rights of third parties are not infringed.

GENERAL NOTES.

THE EXTERMINATION OF MOSQUITOES.—The people of Baltimore seem to have been successful in their warfare with the mosquito. In December, 1906, an ordinance was passed by the City Council, and the sum of £2,000 appropriated by it for the purpose of taking measures to exterminate the insect. In the following May the work began, and the first step taken was a distribution by the police to householders of a notice setting forth the provisions of the law requiring all the cisterns, tanks, and wells to be covered with wire gauze not coarser than 18 wires to the inch both ways; all pools, ponds, fountains, or other water receptacles not containing fish to be screened as above, or covered with crude petroleum; forbidding any water to remain in any receptacle whatsoever; requiring all privy walls to be thoroughly covered with kerosene every 15 days; and that water be turned off, and water receptacles emptied should a house be unoccupied for more than five days. The penalty for neglecting to comply with any of these requirements was a fine not exceeding 2 dols. per day. Dr. C. M. Hill, who had charge of the work, brought the matter more forcibly before the public by delivering a series of lectures explaining the mode of mosquito extermination, and cards were displayed in the tram-cars calling the attention of householders to the importance of their co-operation in the work. Reporting upon the experiment (Annual Series, No. 3982) Mr. Consul Fraser says the result of it is satisfactory, and the City Council has appropriated another £1,000 for continuance of the work in 1908. Dr. Hill is grateful to Dr. Ross, of the Liverpool School of Tropical Diseases, for much valued advice in his efforts to exterminate the mosquito, which has hitherto been the cause of so much illness and death in Baltimore.

Journal of the Royal Society of Arts

No. 2,902. VOL. LVI.

FRIDAY, JULY 3, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

DECIMAL MONEY.

By Colonel Sir C. M. Watson, K.C.M.G., C.B.

We frequently hear it remarked that it would be very advantageous if Great Britain were to adopt a decimal system of money instead of the present system of keeping accounts in pounds, shillings, and pence. There can be no question but that a decimal system is convenient and simple for monetary calculations, and the fact that a considerable number of nations have adopted it shows that there is a good deal to be said in favour of it.

In all decimal systems amounts of money are represented in the following manner :—

a b c
1· 1 1

The figure "a" to the left of the decimal point is the unit of the system ; the figure "b" to the right of the decimal point is the first subsidiary unit, and is equal to one-tenth of the principal unit ; while the figure "c" to the right of the "b" is the second subsidiary unit, and is equal to one-hundreth part of the unit. In most foreign decimal systems the principal unit and the second subsidiary unit have definite names, but the first subsidiary unit has frequently no independent name given to it. In the French system, for example, the unit "a" is called "franc," and the unit "c" "centime," but the unit "b" is known as ten centimes, the original name, "decime," for this unit having fallen into disuse. In the United States, the unit "a" is called "dollar," and the unit "c" "cent ;" the term "dime" is sometimes used for unit "b," but it is not official. In Russia, unit "a" is called "rouble," and unit "c" "copeck ;" while in Scandinavia unit "a" is "krone," and unit "c" is "ore."

It is evident that in any decimal system each unit must be exactly equal to the unit standing to the right of it multiplied by ten, and it is this fact that makes it difficult to apply the decimal system to British money of account.

In our present system of money of account there are two units, the pound and the penny, both of which have descended to us from remote antiquity. Not to go further back than the Norman Conquest, we find that, at that time, the unit of value was the pound weight of silver, and this was also used as the unit of account, although there was no actual coin to represent it. The pound was the old pound of 5,400 grains, which was divided into 240 pennies, these being actual silver coins, each weighing $22\frac{1}{2}$ grains. There was also an intermediate unit of account called the shilling, which had the value of twelve pence, but was not represented by an actual coin.

The distinction between coins and units of money of account is very important, as there may be units in money of account which are not represented by coins, and, on the other hand, there may be coins which are not units of money of account. The half-crown is an instance of this, as, though it is a coin, it is not a unit of account and has to be written in terms of two units, *i.e.*, two shillings and six pence.

The British system of money of account has remained unaltered for many centuries, whereas coins and their values have been frequently changed, and the question of introducing a decimal system of money into this country is not a matter concerning coins so much as concerning an alteration in the method of money of account, which is a much more difficult problem.

It is easy to see that it is not possible to use both the present penny and the present pound in a decimal system of money, as the latter contains 240 of the former and there is no decimal relationship between them. One or other of them must be altered as a unit of account, but it does not follow that it must

cease to exist as a coin. In this country the most important coin is the pound or sovereign, which, in its present form, was introduced in 1817, and has since then been the standard of value. The second coin of importance is the penny, which has a much longer history than the sovereign, and is so bound up with trade that any change in its value, however small, is a very serious matter. The intermediate British unit of account, the shilling, is not so important as the pound or the penny, and it may be regarded as a subdivision of the former or a multiple of the latter.

In considering any system of decimal money for Great Britain two points must be observed :—

1st. That the gold coinage must remain absolutely unaltered in standard of fineness, weight, and value relative to weight.

2nd. That the penny must be retained both as a coin and as a unit of account, and that its value must be altered as little as possible consistently with the first principle.

But when the Parliamentary Committee of 1853 considered how a system of decimal money could be introduced, while adhering to the principle of keeping the sovereign unaltered, they abandoned the penny altogether, and proposed a system based on the pound as the unit. The pound was to be divided into 10 florins, the florin into 10 cents, and the cent into 10 mils. As there are 960 farthings in a pound, and, as it was proposed to divide the pound into 1,000 mils, the latter coin would have had a value a little less than a present farthing. The system proposed by the Committee may be represented thus :—

£1.	Florin.	Cent.	Mil.
1·	1	1	1

This proposal had many serious disadvantages. It gave up the penny and introduced three new units, neither of which corresponded to existing units. It is not matter of surprise that it met with little approval, and that no serious attempt was made to introduce it, although the florin (one-tenth of a pound) had been in circulation as a coin (though not a unit) before the Committee was appointed, and has been in constant use ever since. We may take it as fairly certain that this system of decimal money will never be adopted, and perhaps the fact that it was the best that could be proposed by an important Parliamentary Committee has had a considerable effect in checking the introduction of any decimal system into this country.

It would appear, however, that the conclusion that the pound-mil system is the only feasible one is hardly tenable, and that it would be possible to devise a decimal system, under which the sovereign could be retained unaltered ; while, at the same time, the penny could also be retained both as a coin and as money of account, subject to a small alteration in its value, which would not seriously affect its general use. Such a system might be formed by the introduction of a new unit of account, of which the value, as a gold coin, would be exactly 2-5ths of a sovereign, and by dividing this coin into 100 pennies. As in our present monetary system 2-5ths of a sovereign is equivalent to 96 pennies, the value of the penny would be reduced by 1-25th part, or rather less than 1-6th of a farthing. This is a small amount, and perhaps such a change in the value of the penny might be feasible without great injury to trade.

Before describing the proposed new system in detail, it is desirable to consider what the new gold unit should be called, and, in order to do this, it is necessary to give a short *resumé* of the history of British coinage.

At the time of the Norman Conquest, accounts of money were kept, as at present, in pounds, shillings, and pence, but, as I have already shown, the two former were units of account only, and were not represented by coins, the only coin being the silver penny of 22½ grains in weight. This was the 1-240th part of a pound of silver of standard fineness, as the pound was at that time equal to 5,400 grains. The standard of fineness was 37 parts of pure silver to 3 parts of alloy, a standard which was maintained for many years, except for a short period during the reigns of Henry VII. and Edward VI., and is still maintained at the present day. The shilling was an imaginary coin, equal in value to 12 silver pennies.

There was no British gold coin until the time of Henry III., who, in 1257, introduced a gold penny, equal in weight to two silver pennies, and, in value, to 20 silver pennies. This coin does not appear to have been a success, and no further attempt was made to establish a gold coinage until the reign of Edward III., who issued a gold florin, which was shortly superseded by the noble, a gold coin having a weight of 138·46 grains, and the value of 6s. 8d. in money of account. The standard of the noble was 19 parts of pure

gold and 1 part alloy, and this was afterwards known as the old standard. The weight of the noble was reduced by subsequent kings, but the standard of fineness was maintained. The noble continued to be issued until the reign of Edward IV., when it was replaced by the rial, which weighed 120 grains and was valued at 10s., and the angel, which weighed 80 grains, and was valued at 6s. 8d. These were both made of the old standard, which was afterwards sometimes called angel gold.

Henry VII. continued the issue of rials and angels, to which he added a new gold coin, the sovereign, 240 grains in weight and valued at £1. The silver penny had been gradually diminished in weight, and in the reign of Henry VII. was of 12 grains instead of 22½ grains. Henry VII. also introduced a silver shilling, and the reign of this king is noteworthy in the history of our coinage, as then for the first time the pound and the shilling became real instead of imaginary coins.

His successor Henry VIII. also issued sovereigns, rials, and angels, to which, in 1526, a new coin was added, the gold crown, which was made of a new standard of fineness, and contained 22 parts of pure gold and 2 parts of alloy. This was known as crown gold or the new standard, in order to distinguish it from angel gold or the old standard. Crown gold, or, as it is sometimes called, 22 carat gold, is the standard of fineness used for British gold coins at the present time.

The first gold crown pieces issued weighed 57·36 grains, but this was considered too heavy and, in 1544, the weight was reduced to 48 grains. In the latter part of the reign of Henry VIII. both the gold and silver coins were much depreciated in value, but they were restored to a satisfactory condition by Edward VI. and Queen Elizabeth. Edward VI. issued a silver crown for the first time, as previous to this the shilling had been the largest silver coin.

The coinage of rials ceased in the reign of James I., and of angels in the reign of Charles I., the last issue of the angel being in 1634; after this time the gold coins were sovereigns and crowns, both made of the new standard, or crown gold. By this time, the sovereign had been reduced to a weight of 140·5 grains, and the crown to a weight of 35·12 grains of standard gold. Similar coins were issued by Charles II. on his accession, but, in 1662, as the value of gold had risen considerably, they were both given up and replaced by a new coin, the guinea, which weighed 129·438 grains.

At its first issue the value of the guinea was fixed at £1 0s. 0d., but it rose in a short time to £1 1s. 0d., and frequently varied in value up to 1717, when it was definitely fixed at £1 1s. 0d.; the guinea remained of this value until 1817, when it was superseded by the new sovereign.

The value of the sovereign was fixed at £1 0s. 0d., and its weight at 123·274 grains, exactly 20-21th parts of the value and weight of the guinea. It has never since been altered and, having regard to the history of the subject, it would be most undesirable to make any change in British gold coinage in the future, either in standard of fineness, or in weight relative to value.

As the value of the new gold unit, which it is proposed should be the unit of a decimal system of money, would be two-fifths the value of the present sovereign, its weight, as a coin, should be 123·27447 grains multiplied by two-fifths, or 49·30978 grains. This would be nearly the same as the weight of the gold crown of 1544, and, having regard to the fact that the gold crown of Henry VIII. was the first coin for which the present standard of fineness was used, it would appear that the most suitable name for the new unit would be "crown." To adopt this name would be following the same course as was taken in the case of the sovereign: that coin was introduced by Henry VII., replaced by the guinea in the reign of Charles II., and re-introduced by George III. Similarly, it would not be unreasonable that the gold crown, first issued in the reign of Henry VIII., and given up in the reign of Charles II., should be re-introduced by his Majesty King Edward VII. This coin would also recall another interesting historical fact. As the sovereign weighs 123·27447 grains and is made of 22 carat gold, it contains 113·0016 grains of pure gold. The proposed crown would therefore contain 45·2 grains of pure gold, which is the amount of gold that was contained in the gold penny of Henry I. The coin, which, it is suggested, should be the principal unit of a decimal system of money, would thus be equal in weight of pure gold to the penny of 1257; and of the same standard of fineness, and almost of the same weight, as the gold crown of 1544.

Adopting the gold crown as the unit of money of account, and dividing it into 100 pennies, the proposed decimal system may be represented as follows:—

Crown.	Penny.
1·	11

This would be in accord with the usual system of decimal money, and would be much simpler than the system of pounds, florins, cents, and mills proposed by the Parliamentary Committee of 1853.

Although the unit of money account would be the gold crown, sovereigns would continue to be used without any difficulty, as one sovereign would be equal to two crowns and a half, two sovereigns to five crowns, and so on. But it would be advisable to coin no more half-sovereigns, as the gold crown would be too nearly the same size; for this reason too, the crown should have its value, "One Crown," clearly stamped upon it, so as to prevent the possibility of mistakes. It might be advantageous to issue notes of five and ten crowns, making these of smaller size than the £5 note.

All existing silver coins could continue to be used under the proposed decimal system, but it would be necessary to issue a tenpenny piece and a fivepenny piece. As the shilling is 1-60th part of a troy pound of standard silver, the tenpenny piece should weigh, if made exactly in accordance with the present silver coinage, 69·818 grains. This is very nearly 70 grains, and it might be better to make the coin of the latter weight, as it would then be exactly 1-100th of an avoirdupois pound, and could be used as a weight. This would appear reasonable, especially as the troy pound is no longer a legal weight. If the tenpenny piece were made 70 grains in weight, the fivepenny piece should be 35 grains or 1-200th of a pound.

No change would be required in bronze coinage, as the penny, halfpenny, and farthing would continue in circulation.

The following Table shows the value of existing coins in the proposed decimal system, and the manner in which they would be written:—

Coins of Present System.	Value in Decimal System.	Written in Decimal System.
Sovereign	$2\frac{1}{2}$ crowns	.. C. 2·50
Half Sovereign	$1\frac{1}{4}$,,	.. C. 1·25
Five Shilling Piece ..	60 pence	.. C. 0 60
Double Florin	50 ,,	.. C. 0·50
Half Crown	30 ,,	.. C. 0·30
Florin	25 ,,	.. C. 0·25
Shilling	12 ,,	.. C. 0·12
Sixpence...........	6 ,,	.. C. 0·06
Threepenny Piece	3 ,,	.. C. 0·03
Penny	1 penny	.. C. 0·01
Halfpenny	$\frac{1}{2}$,,	.. C. 0·005 or 0·00$\frac{1}{2}$
Farthing	$\frac{1}{4}$,,	.. C. 0·0025 or 0·00$\frac{1}{4}$

It is proposed that the florin should be valued at 25 pence, so that it should be exactly equal to one quarter of a gold crown, and the double florin at 50 pence, so as to be equal to the half of a gold crown. The present weight of the florin is 174·545 grains. It would be desirable in future issues to increase this to 175 grains, so that the florin might be equal in weight to $2\frac{1}{2}$ tenpenny pieces, or 1-40th of a pound weight of silver.

No change would be required in bankers weights for gold, as the 10 sovereign weight would be the weight of 25 crowns, the 20 sovereign weight that of 50 crowns, and so on.

Although the pound would no longer be used as the ordinary unit of money of account, it could still be used, if desired, in the statement of large sums; and, as I have explained, the sovereign, as a coin, would remain unaltered. The process of conversion from pounds to crowns, and *vice versâ*, would be very simple. To convert a sum of money expressed in pounds to the corresponding amount expressed in crowns, all that is necessary is to add an 0 and divide by 4; and to convert crowns to pounds, it is only required to multiply by 4 and strike off the last figure. For example, £82,492 is equivalent in value to C.206,230.

The proposed unit would be convenient for the conversion of British money into the monetary systems of other nations. Taking, for example, some of the more important of these, we have the following equivalents:—

France	10 francs	equal to	1·00	crown.
Germany	8 marks	,,	0·99	,,
India	6 rupees	,,	1·00	,,
Holland	5 florins	,,	1·04	,,
Russia	4 roubles	,,	1·04	,,
Japan	4 yen	,,	1·00	,,
United States..	2 dollars	,,	1·03	,,
Portugal	2 milreis	,,	1·00	,,

Of course the relative value of the different coins vary slightly as the rate of exchange alters, but the above Table will show that the proposed gold crown would be a very convenient unit for comparison with the monetary systems of other nations.

The principal objection to the proposed decimal system is that the value of the penny

relatively to the gold unit is reduced by 1-25th part, and this is undoubtedly a serious one, but it is, perhaps, not insuperable, and to introduce a decimal system without this small change would be very difficult. If, for example, the penny was maintained at its present value, and was taken as the lower unit of account, then the higher unit, equal to 100 pennies, would be 5-12ths of £1, and would have no satisfactory relationship to the sovereign, as five units would be equal to £2 1s. 8d., and ten units to £4 3s. 4d. With such a system the sovereign would practically have to be given up, and this is inadmissible. The objections to such an arrangement would be far greater than to making the new unit equal to 4-5ths of a sovereign, and dividing this into 100 pennies.

But if the very small reduction of the value of the penny which I have proposed is regarded as too serious to contemplate, then the only alternative that remains is to abandon the idea of introducing a decimal system of money into this country, and to adhere to the time-honoured British system of pounds, shillings, and pence. That this would be the course preferred by many people is probable, but it would be difficult to say whether they are in a majority. One thing is certain, and that is that a system of decimal money should not be introduced without a most careful consideration of the effect it would have on the commercial transactions of all classes of the nation.

THE INDUSTRIAL OUTLOOK IN JAPAN.

In recent years the proportion of Japanese foreign trade which has found its way into the hands of native importers and exporters, thus avoiding the foreign merchant houses who were at first instrumental in holding up Japan's over-sea commerce, has steadily and continuously increased. One of the causes which has produced this result is to be found in the financial assistance which the Government affords to native traders through the medium of the Yokohama Specie Bank, this bank being entitled to get foreign bills of exchange re-discounted by the Bank of Japan to an amount not exceeding £2,000,000 at a rate of 2 per cent. per annum. Another cause is the desire of European and American manufacturers to get into direct trade relations with the natives. It is a common belief that Japan has before her an important future as a manufacturing country, and that in time she will be able not only to supply most of her own wants, but also to drive European and American manufacturers out of the Far-Eastern markets. This opinion rests largely upon the knowledge that Japan has plenty of coal, a great number of waterfalls which will in time to come be harnessed, and an abundant supply of cheap labour. But in his interesting report on the trade of Japan just issued (No. 4026, Annual Series), Mr. E. F. Crowe, Commercial Attaché to His Majesty's Embassy, Tokio, points out that the position in these respects may not be maintained. Coal is no doubt to be found in considerable quantities in Japan, but prices have risen so much of late years that the cost of production for those mills which require to use a great deal of it has grown to an unthought-of extent, and unless their owners reduce their prices this one factor alone must have a serious effect on Japanese trade. Coal, which in 1903 cost 11s. 5d. a ton, had increased to between 13s. and 14s. in 1906 and 1907. Even more important than coal is the labour question. Japanese labour has been very cheap in the past, the average daily wage for male operatives being 10½d., and for females 5¾d. These are the figures for 1905, the latest reliable ones yet published. According to the returns compiled by the Bank of Japan, however, the price of commodities has been gradually increasing. Rice, which forms the preponderating proportion of Japanese workmen's food, reached a record price in August and September, standing at 18 yen per koku, although it has fallen since then. The price of tobacco has been increased, and saké, sugar, and kerosene, all of which are consumed to a certain extent by the labouring classes, will advance in cost in consequence of the increased taxation recently sanctioned by the Diet. The people, too, are gradually developing more luxurious tastes, and though this is, perhaps, a good sign in one way, it shows that there can only be a small margin, if any, left over after the operative has paid for his daily expenses. The result of this will be that wages will have to be increased, and that in time one of Japan's chief advantages will disappear. As a matter of fact, there has been an advance of wages during the past year, although there were many who asked for enhanced payments but were not successful in their demands.

At present there is no factory legislation in Japan, but leading men are advocating the necessity of introducing some measure under which the large mills, now springing up in various parts of the country, should be controlled. In most of the old-fashioned concerns there are two days of rest a month, on the 1st and 15th, but in many of the new and large mills a holiday is taken either every seven or ten days, and this enables the day and night shifts to alter. The average length of the working day is ten hours, not including the time set apart for meals, but Mr. Crowe thinks it doubtful whether the actual amount of work performed surpasses what the British workman does in a shorter time. Even where payment is by piece-work, there is not found in Japan either the intensity of application, or the high standard of skilfulness which a Western mill manager demands. No doubt

when factory laws are introduced they will be based to a certain extent on Western models, and it would seem almost unavoidable that there should be consequent increase in the cost of production.

Hitherto British capitalists have found great difficulty in carrying out their schemes in Japan, but the steel foundry to be established at Muroran, in the Hokkaido, by an Anglo-Japanese syndicate, promises to be an exception to the rule. It consists, on the one side, of two well-known British companies, and on the other of the Hokkaido Colliery and Steamship Company. The capital of the new concern is £1,000,000, of which one half will be found by the British companies, and the other half by the Japanese, while any further capital required will be arranged for by both parties. The actual board consists of four Japanese directors, four British directors, and one neutral director, who is also a Japanese, but as regards the Board in Japan two of the British votes are represented by one Japanese, so that it would seem that the Japanese have at present a controlling vote. Mr. Crowe says that the Japanese Company will provide the coal from their own Yubari collieries, in the neighbourhood of Muroran. It had not on the date of Mr. Crowe's report been decided what iron ore will be used, but experiments are being made with ferruginous sand, which is found in large quantities in the Hokkaido. The Nippon Seikosho, as the steel foundry is called, will have the right to use any process patented by the British firms necessary for the steel works operations, free of royalties, while the Japanese Colliery Company will transfer the lease of such lands as have been allotted for the steel works at the original rent. It is provided in the agreement that wherever prices offered are equal, the foundry shall give preference to the British companies in the purchasing of goods. Mr. Crowe says that on the date of his report some £750,000 worth of British machinery and material was on its way out. The foundry will probably not be in a position to commence serious operations before the middle of 1909. The working of this joint enterprise will be of unusual interest to all those concerned in Japanese trade. It will not only afford a valuable clue to the possible success or failure of other joint schemes which are at present on the *tapis*, but it will give an indication as to whether it is best in combined undertakings that the control shall be in foreign or in Japanese hands.

Japan suffers much from fire and flood, and Mr. Crowe directs attention to them. The inflammable nature of the ordinary house, and the lack of proper engines and of a sufficient water supply often turn a trifling blaze into a serious conflagration. Leading British manufacturers of fire engines are represented in Japan, and exhibitions have been given by sellers of fire extinguishers, but the country as a whole remains content with the trumpery native appliances. Only a few months ago the town of Hokodate was nearly wiped out by a terrible fire. To make matters worse, those who had assured with some of the small native companies failed to get reimbursed for their losses. Considering how stringent the Government regulations with respect to insurance are supposed to be, it is strange, Mr. Crowe thinks, that the dangerous condition of the companies was not ascertained at an earlier date and their operations restricted. The nationalisation of the railways of Japan was completed last year, when the last of the 17 principal private railways was taken over in October. The promised improvement in the service is not yet apparent.

THE CITRUS FRUIT INDUSTRY OF CALIFORNIA.

The citrus fruit industry of California has grown up gradually. It began to assume commercial importance in the year 1880, and in 1886 it amounted to a thousand car-loads of three hundred boxes each. Between 1890 and 1895 it had increased to from four thousand to seven thousand car-loads annually, and from 1900 to 1907 to between twenty-four and thirty-two thousand car-loads annually, *i.e.*, from six million to eleven million boxes, having a gross value of from £5,000,000 to £6,400,000. The lemon comprises from ten to fifteen per cent. of the citrus crop. There are a few pomelos (grape fruit) grown. Three-fourths of the oranges are of the Washington Navel variety, the remainder comprising the Valencia, as the most important variety, and the St. Michael, Mediterranean sweet, Thompson, Ruby, Maltese blood, Jaffa, seedlings, and Tangerines. There are about sixty-five thousand acres of citrus fruits in California, distributed among some six thousand growers. From ninety to ninety-five per cent. of the citrus fruits are shipped to markets outside California. The citrus fruit industry has, according to a recent bulletin of the United States Department of Agriculture, reached its greatest development in Southern California, which is made up largely of the San Bernadino, San Gabriel, and San Fernando valleys. It has become most prominent in the foot-hill regions and lower lands extending down from the San Gabriel and San Bernadino mountains which make up the Sierra Madre range; in the river-side district; at the base of the Temescal range, and in the coast region in Orange and Los Angeles counties. There are smaller and not less favourable regions in Santa Barbara and Ventura counties, close to the mountains, and in San Diego county. In recent years the industry has been developing north of the Tehachapi range of the Serra Madre Mountains, especially in Tulare, Kern, Fresno, and Battle counties, though oranges are grown to a limited extent in other fruit-growing counties in the central and northern parts of the State as well. The greatest development has occurred in Tulare county, where the annual production is now about two thousand car-loads of oranges, mostly of the Washington Navel variety. New plantings have been made, which, under favourable conditions, may increase the annual

production in that district to ten thousand cars in the next few years. The orange crop of Northern California matures from four to six weeks earlier than it does in the southern part of the State, notwithstanding that it is from two hundred to five hundred miles further north. This unusual condition is due to the topography of the Pacific Coast. The large inland valleys of northern and central California lie between two great mountain ranges, extending north and south. The Coast Range Mountains shut off the modifying influences of the sea, causing relatively higher night temperatures during the summer months than prevail in the southern part of the State. Citrus fruits are grown in California on many types of soil under an intensive system of orchard management. Irrigation is necessary, except from December to April, when the rainfall usually occurs. As in other horticultural industries in the United States, there has not yet been developed a uniform system of management in respect to the treatment of the soil, the use of water, the application of fertilisers, or in the treatment of the trees. In a general way it may be said that the tillage is frequent and thorough during the season from March to August or September; that cover crops, especially winter vetch, Canada peas, and burr clover, are coming into general use as a winter covering, and as a means of improving the condition of the soil; that pruning, except with the lemon, is not systematically practised, and that commercial fertilsers of various kinds are probably used more extensively than in any other orchard industry in the country, except in citrus fruit growing in Florida. The groves vary in size, the smaller ones containing from five to ten acres, the latter being a common unit of size. There are many groves of fifteen to twenty acres or more, and the groves of some growers range from one hundred to two hundred or more acres. There are a few large companies and corporations engaged in the business, some of them having from 250 to 2,500 acres of citrus fruits. The harvesting of the Washington Navel crop begins in November in northern and central California, and extends to the middle of June, or the first week in July in southern California. The Valencia season opens at the latter part of May and extends into the latter part of September or beginning of October, the trees at that time bearing the crop to be harvested and the partly developed fruit for the crop of the following season The other varieties of oranges are harvested from February to July. The lemon is picked from the same grove in practically every month of the year, although the largest part of the crop is harvested from November to May, a single tree generally containing fruit in all stages of development, from the blossoms to the mature lemon. The citrus fruit growers of California are as a class men of high intelligence, and many of them are of large business experience and capacity. Co-operation in the handling of the citrus fruits is the corner stone on which many of the successful businesses in California rest. Among the various systems of marketing the fruit there have been developed some of the best examples of co-operative organisation among fruit growers to be found in America. These co-operative associations, organised primarily for the business of packing and distributing the fruit, handle from 70 to 75 per cent. of the entire citrus fruit crop. The citrus fruits of California are distributed to markets throughout the United States and Canada, and also to European countries. They are despatched under a specially organised refrigerator car service. From November to the middle of March during which period about one-half of the crop is sent off. The weather in California and throughout the territory *en route* to distributing points, is cool, and consignments are made under ventilation without ice, the ventilation of the cars being regulated by the railway company under instructions from the growers. After the middle of March, cool weather in California or in transit, cannot be relied upon, and ice is generally used for refrigeration. Early in the season, especially during January and February, when the fruit is packed in a cool condition it may be frozen in transit, unless special precautions are taken to protect it. Occasionally after the middle of March the fruit may be loaded at a temperature of 80° to 100° Fahrenheit, but a large proportion of it is packed at a temperature of not above 65° Fahrenheit, even as late as the 1st of June. A standard car forty feet in length usually contains 384 boxes of oranges loaded two tiers on end and six rows wide. The boxes have a weight of 72 pounds each.

THE COMMERCIAL CONDITION OF MOROCCO.

The import trade of Morocco is valued at about £5,000,000, and, of this amount, the greater part goes into the coffers of the merchants of England, France, and Germany, with the first two at present struggling for supremacy. Despite the many centuries of life, Morocco has not been developed—it is almost virgin territory. Its forests and mines are intact. The American Consul at Tangier says that there are no railways, no electric transportation lines, no telephones, no telegraph to speak of, electric lights of more or less uncertain existence only in one town; the coast known, the interior a wilderness, where even the Sultan dare not go. While the interior of Morocco is as represented above, a wilderness, the coast is more or less accustomed to European methods —the people eat French sugar, drink English tea, and wear Manchester cottons. In the eight port towns and vicinity there are quite enough people to satisfy ordinary demands as regards the opening up of fresh trade. At present cotton goods from the United Kingdom alone amount to £800,000 a year. Sugar is imported to about the same extent annually. Candles reach nearly £100,000 a year, and tea, £150,000. A very serious hindrance to the develop-

ment of internal trade is the entire lack of any practicable means of transportation and communication. When it is noted that in a country covering more than 300,000 square miles, there is not a single railway or other means of mechanical transportation, the fact that internal commerce is restricted does not seem strange. Morocco, exposed on the north to the Straits of Gibraltar and the Mediterranean, and on the west to the Atlantic, offers every inducement to the development of commerce, but up to the present the policy of discouragement of foreign enterprise has kept out would-be developers—a policy which has been greatly assisted by the disturbed political conditions and lack of law. Foreign capital, however, has managed to secure a foothold along the coast of the country. Tangier is the northern commercial centre. The west coast has many, such for example as Laraiche, Rabat, Casablanca, Mogador, Mazagan and Saffi, all of which have a more or less flourishing import and export trade, fed by the coastal and interior area within a radius of perhaps thirty or forty miles. Outside of these pocket-like areas the country is self-supporting, although, necessarily, small quantities of tea, candles, sugar and cloth go inland. Fez and Marrakesh (Morocco), the northern and southern capital cities, attract some little import trade which, however, goes direct from the nearest port, and has no developing influence upon the 150 or 200 miles of intervening territory. There are in Morocco no roads which could properly be called such and not more than a dozen bridges, and those only over small streams where the most simple forms of construction could be employed. Rivers must be forded, and when the water is high, as is often the case, there is nothing to do but wait until it subsides. Aside from the occasional "fandak" (enclosures where animals may be stabled) there is no facility for "putting up" except in the open air. The traveller in Morocco must carry all things with him and prepare to sleep where he may. There are six methods of transportation in general use in Morocco, or perhaps it would be better to say that there is but one method with six variations. In order of their importance these are—mule, horse, donkey, camel, woman, man. Of these the mule, horse and camel may be classified as animals which, generally speaking, are used to transport heavy loads over long distances. The mule can carry all that can be piled upon it, say 600 pounds, for an unlimited distance, as can also the camel. The horse receives more consideration, travels long distances but is never burdened so heavily. A donkey can carry several hundred pounds almost any distance but is generally used for short journeys. Woman is preferred for the carrying of loads of 50 to 100 pounds of firewood, fodder, charcoal, farm produce, &c., from the country to the towns, her journey varying in length from two to fifteen miles each way. Man is used principally as a courier for the carrying of messages over long distances, although in the cities there are many Soudanese or low-caste Moors who transport heavy objects. Vehicles are practically unknown; Tangier alone, of the Moroccan cities, has a number of wheeled vehicles, perhaps a dozen, most of which are heavy carts imported by the Foreign Sanitary Commission for use in keeping the streets clean. Owing to the absence of roads, vehicles would be useless, but roads, says the Consul, will come hand in hand with railways. The Consul goes on to say, "it is probable that no other country has the field for future development which Morocco has, one reason being its present primitive state, which allows development in every imaginable direction, and another being its vast natural resources, which make such development profitable and possible. Once the real development of the country really begins, the wealth of the country will be surprising. Mines of lead, zinc, tin, antimony, silver and gold will be opened. Extensive irrigation systems, through a tapping of the four large rivers and the sinking of artesian wells, will treble the area of land fit for agricultural purposes, and the introduction of modern farm machinery will treble the production per acre. Fruit farms will be worked on a scale equal to the vast farms of California, conditions for fruit-growing being as good or better than those of that State. It has already been demonstrated that silk culture is especially adapted to becoming a cottage industry in Morocco, the quality thus produced being equal to the best Italian. Cotton has been grown in Morocco, and the best botanical authorities unite in praise of the natural conditions for such an industry. Railways supplanting the mule and the canal, would unite the country, making possible the sale along the coast of fruit and grain grown in the interior, a thing now almost unheard of. Building is now confined to the thin fringe along the coast, because of the impossibility of transporting building materials inland. Fisheries would be conducted on a large scale, one at Tangier already having demonstrated its practicability. Manufactories, even, would soon be necessary to supply the demands of the people."

THE TRADE OF SICILY.

Some interesting facts and particulars of British trade with Sicily are contained in the latest Consular Report (Cd. 3727-108) on the trade and commerce of the country for the year 1907. The population of the island is rather more than $3\frac{1}{2}$ millions, and during the year 1906 there was a shrinkage of 17,175 inhabitants. The chief products comprise grain, a large proportion of which is grown in the province of Catania in the east of the island; maize, nearly all of which comes from Messina, and rice from Syracuse; wine, olive oil, oranges and lemons, tobacco, textiles and fisheries. From Palermo, the principal port, the chief exports are green fruit, vegetables, almonds, sumach for tanning purposes, olive oil, tomato paste, and raw hides. The value of the imports from the

United Kingdom into the port in 1906 was £278,678, while the exports were £212,749. The former have increased during the last five years, while the exports have declined. There is a shipbuilding yard belonging to the Italian union of shipbuilding establishments at Palermo, and during 1907 the *Europa* (10,500 tons), the biggest merchant steamship yet constructed in Italian yards, was launched therefrom. British shipping resorts to the port of Palermo in increasing numbers and tonnage, the latter having risen from 427,750 tons in 1902 to 685,330 in 1907. The principal article of import trade from the United Kingdom is coal, 182,892 tons (metric) of which were brought into Palermo in 1907. A good deal more than half the total quantity of coal that reaches the island is conveyed in British bottoms. Sulphur, a well-known Sicilian product, has been exported in diminished quantities during the last few years, the American competition being an increasingly embarrassing feature.

During 1907 the Parliamentary Commission to inquire into the condition of agricultural labour in Sicily visited the island, and the general impression was that the want of efficient means of communication is at the root of the chief evil which arrests agrarian development. Some of the roads connecting towns actually visited by Consul Churchill (the author of the present report) were quite impracticable for wheeled traffic. During the winter of 1907-08 the disturbed financial conditions of the United States set back the current of emigration towards Italy and many Sicilians returned home, proposing to emigrate again to America when the labour market should be more promising. Vineyards are now being reconstructed all over Sicily. Many of the stock are beginning to bear fruit, but this unfortunately coincides with the reconstitution of vineyards elsewhere, the result of which is likely to be an overproduction of wine, with the consequence of very low prices. The prospects of the olive culture for the season 1907-8 are very satisfactory, the fruit being excellent and in good condition.

The railways in Sicily are part of the general system of Italian State Railways, the only lines not belonging to the State being two branches in the vicinity of Mount Etna, one of which is a British undertaking. The State has authorised the construction of new lines extending to about 280 miles, at a cost of above two millions sterling.

In order to impart greater elasticity in their revenue, the Palermo Municipality took over the gas works, and in spite of increased pay to the workers and a reduction in the charge for gas it is estimated that the profits for the current year would be about £16,000. Various improvements in the postal service, telegraphs and telephones are being carried out, and a wireless telegraph station is to be set up at Palermo in communication with Naples and Cagliari.

Very few commercial travellers have been to Sicily during the last year or two; most of the British trade comes to Sicily through agencies in Milan, Geneva, and Naples. Immense quantities of hardware, enamelled goods and nails are sold in the island, most being of German origin, and there are opportunities for trade in fancy goods of various kinds. In hotel enterprise there is room for the employment of British capital, especially in regard to new sites.

The other ports of Sicily do not call for special notice, except perhaps in the case of the western port of Marsala, where the abundant vintage brought about a decline in prices of wine, the quality being lower than in 1906. A new steamship company, called La Sicania, has lately been formed in Trapani, with a branch at Marsala, for carrying Sicilian wines to the principal ports in the Mediterranean, Ionian, and Adriatic Seas.

THE FORESTS OF ASIA MINOR.

The trees of which the forests of Asia Minor are composed, are the fir, pine, cypress, cedar, juniper, birch, chestnut, oak, plane, poplar, linden, beech, elm, ash, and willow. The old forests have disappeared, and the tendency of nature to prepare the soil for a second growth is being continually defeated. As no industry has ever laid claims, to any great extent at least, upon the forest of Asia Minor, their disappearance can be attributed only to the demand for fuel. Fir and pine forests now exist only on the high plateaus, or mountain ranges, such as the Paphlagonian mountain range, which is situated towards the shores of the Black Sea. In this district the rainfall is greater each year than in the vilayet of Smyrna. Beech, plane, and elm trees also thrive in the valleys and plains. In Armenia there are large forests of red beech, walnut, oak and chestnut. The American Consul at Smyrna says that there are reported to be forests of large beech trees in the country at the back of Trebizond, at some distance from the coast, and in the Ak Dagh Mountains. It is also said that there are forests of tall pines not far from Angora. Between Smyrna and Konia there are no forests of importance. The willow tree which grows well in some parts of the country, especially near Angora is, to some extent, protected from the inhabitants on account of the shade it affords in summer, and because it grows rapidly, and is supposed to act as a preventive against fever. The whip-like branches are often woven into bee-hives. The poplar is frequently found in large groves scattered about the countryside, and is used chiefly in constructing houses in the Turkish villages. The Oriental plane tree is found all over Asia Minor, but seldom in groves. They usually stand alone along the roads, and serve the traveller as halfway stations, where he finds some protection from the summer sun. These trees also add considerably to the scenery of the country. They grow to be several hundred years

old, and often attain such size that shepherds have been known to cut huts in the trunks of the standing trees, and their vitality is so great that they continue to live for years afterwards. The plane is also a favourite shade tree. Smyrna has none, but Constantinople and the little villages leading away from the Bosphorus, as well as most cities and villages in the interior, have large numbers of them. The Turks are fond of having them in front of their cafés, and in the yards of their mosques. The Oriental cypress is a stately tree, which grows to exceptional size in Turkey, and especially along the coast of Asia Minor. It is revered by the people, and is planted in groves in every Turkish cemetery. These trees are an ornament to the country, and no Turkish landscape is complete without them. In the old cemetery of Smyrna the grove is several hundred years old. In various parts of the vilayet of Smyrna a certain kind of scrub oak flourishes, upon the leaves of which a gall wasp lays its eggs. These eggs become secreted in the cells of the plant, and after a time form excrescences the size of a berry, called gall nuts, from which a winged insect makes its way out and escapes. The nuts are green and white in colour, and some 3,000 to 4,000 sacks are shipped to England, Germany, and Austria every year. Some gall nuts are exported to America for the purpose of making ink, but only small quantities are shipped from the port of Smyrna. In the opinion of experts the quality of the timber in Asia Minor is good. The State reserves to itself the control of the forests at all times, but there does not appear to be any regularised system of forestry, with the exception of a few experiment stations. The peasants are permitted to chop and burn freely. A Government permit is necessary only in case timber is to be exported. The owner of some forests near the head waters of the Boli Su River, who holds a permit to export timber, has given the following description of the manner in which timber is obtained in that district. Along most of the rivers which flow into the Black Sea there are many primitive saw mills, only a few of which are equipped with steam-engines. The logs are dragged down the mountain side by horses and oxen and rafted down the Boli Su to the mills, where they are sawn into lumber for shipment to Constantinople or other parts of Turkey. Nomad tribes who in winter house themselves and their flocks in timber huts have done much harm to the forests of Asia Minor, especially in the vilayet of Smyrna. In order to obtain the necessary logs or poles for building their huts they help themselves to any unprotected timber in the neighbourhood. The disappearance of the forests, especially in the vilayet of Smyrna, has been marked by greater degrees of heat and cold. The date palm has practically become extinct here. In the winter and spring there are usually floods, which are destructive to life, property and crops. In the summer there is not sufficient moisture in the soil of many districts, for the reason that the rain passes away at once down woodless ravines without being absorbed by the ground. As a result large tracts have become sterile. Crop failures and famines in Asia Minor may therefore be traced to the lack of forests. The demand for timber of every description in Smyrna may be stated as follows :—Boxes and cases for the fig and raisin industry; hard wood for flooring; mahogany and walnut for furniture and cabinet-making, picture-frames and wood ornaments. There are a few sawmills in Smyrna which make a business of sawing and planing imported timber into the sizes desired by the local trade.

FRENCH BAUXITE.

According to official figures, the quantity of bauxite exported from France in 1907 was 110,915 tons, valued at £95,000. The French deposits, which were the first to be discovered, continue to be the most important in the world, both in extent and value. The first valuable beds were found in the neighbourhood of Les Baux, a few miles to the west of Marseilles, which accounts for its name. At present, according to the American Consul-General at Marseilles, the chief sources of supply are in the department of the Var, a few miles east of Marseilles, from which exports are made. From a mineralogical point of view, bauxite is a non-silicated earth of the oxide family. It may be compared somewhat with corundum, and with emery, which is merely a variety of corundum. Indeed one of the chief uses to which it is put in the United States, is for the manufacture of an artificial corundum. It is also utilized in that country in the manufacture of aluminium, alum, and various refractory products. This last application is of comparatively recent origin, and is by no means so extensively generalised as in France, although it is beyond doubt, that as a refracting material for lining furnaces in which the corrosive action of the basic slag must be resisted, the utility of bauxite is very great. The Consulting Engineer of the city of Marseilles has stated that in 1907 the production of aluminium was 25,000 tons, requiring for the manufacture thereof 120,000 tons of red bauxite; the manufacture of refractory products consumed 180,000 tons of other bauxite; the total production of this mineral, therefore, was 300,000 tons in 1907. Since a year ago the exploitation of French bauxites has developed considerably, this being due to the fact of the establishment of a number of new factories, in which use is made of processes the patents for which have expired. Rich deposits of the mineral have been found in different localities, until now unexplored, and the newly-organised companies have eagerly taken up concessions, some of which may or may not be actually worked. In the opinion of the Marseilles engineer the French bauxite deposits are inexhaustible. Almost every day new pockets are brought to light, which are

not utilised. After the exhaustion of deposits of bauxite yielding from 60 to 65 per cent. of aluminium, the aluminium industry will have in reserve deposits yielding bauxites containing 45 to 47 per cent. of aluminium, these latter deposits being practically inexhaustible. The refractory products manufactured from white bauxites, containing from 40 to 45 per cent. of aluminium, are much sought after in France for use in industries where exceedingly high temperatures are maintained. Cupolas, locomotive fire-box linings, and glass furnaces are manufactured of bauxite bricks, which give special satisfaction. These products are sold at high prices. Practically the total production of white bauxite from the Department of the Var is shipped to manufacturers of refractory products in Belgium. The most expensive quality of bauxite is the white ore, which yields 60 per cent. of aluminium, 4 per cent. almost of iron, and which is without silica. This ore is utilised in the manufacture of chemicals. Next in value comes the red bauxite, containing 60 per cent. of aluminium and 3 per cent. of silica, which is converted into aluminium. Third in order comes a special white bauxite for the manufacture of refractory products, containing 45 per cent. of aluminium, traces of iron, and much silica. These are the broad descriptions of the three standard grades shipped by French producers.

THE FISHERIES OF BENGAL.

Mr. K. G. Gupta, late of the Bengal Revenue Board, and now member of the Council of India, is the author of a very important Report of over a hundred closely-printed foolscap pages, issued from the Bengal Secretariat, on the subject of the Fisheries of the Lower Provinces. The object in view is of course to improve and develop the fish supply, and for this purpose Mr. Gupta was deputed to examine the most important areas in Bengal as well as the United Kingdom, America, and a few places on the Continent. The population of Bengal is about $50\frac{1}{2}$ millions, of which about 40 millions are fish-eaters; for these the chief fish supplies are derived from the rivers, estuaries, *jhils*, rice-fields, and lakes. It is estimated that the rivers furnish a perennial surface of 2,250 square miles, which spreads out many times over during the rains, while the aggregate never-failing inland water area of the Province (including the large Chilka Lake) is not less than 8,000 square miles, an area which, during the four months of the rainy season, is more than doubled. One of the most valuable of the estuarine fisheries is the Sundarbans. The main portion comprises a vast tract of forest and swamp, 195 miles in length, with an average breadth of about 44 miles. It is intersected by large rivers and estuaries running from north to south, and connected by a network of branches, which in their turn, are joined by innumerable smaller channels interlacing in every direction. Its countless waterways are full of most valuable fish and crustacea — an enormous supply which is barely tapped, for the fishermen are few, the boats are unseaworthy, and there is no arrangement for the quick despatch of the catches from the fishing grounds. As to the open sea, there is no fishing or proper utilisation of the vast stores therein contained. Dr. Alcock, naturalist to the Indian Marine Survey, says, in an appendix to the Report, that though at present unknown, uncared for, and unappreciated, the sea fisheries are of a value well-nigh incalculable, and will prove a mine of wealth. As a step to the proper turning to economic account of these maritime fisheries, Mr. Gupta says it is essential that Government should make a systematic survey of the bay, so that the favourite haunts and periodic migration of the fishes may be ascertained and recorded, and practical demonstration given as to what the sea is capable of yielding. If the results are promising, Mr. Gupta thinks that private enterprise is sure to come forward and take up the business on commercial lines. A vessel of the latest type of steam trawler used on the east coast of Great Britain is necessary, as well as a staff of expert fishermen from England, with all necessary appliances. Mr. Gupta points out as a precedent that the Government of the Cape Colony brought a steam trawler with excellent results to their waters, and he considers there is a great opening for such trawlers in the Bay of Bengal. The main object is the opening up of a rich supply of food material, which has been hitherto overlooked or neglected, for the people of the country. As regards the transport to market of the catches, speed is of the utmost importance, and for this purpose gasoline and petrol boats, which are finding increasing favour in Europe and America, would be very suitable both in the estuaries and rivers of Bengal. The mechanism is simple and inexpensive, and can be adapted to both large and small boats. For preserving and curing fish ice and salt must, of course, be both easily procurable and cheap, and as regards the last item, the report recommends that the salt required for curing or preserving fish should be relieved of all duty. Mr. Gupta adds, he is more than ever convinced by his investigations of the necessity of organising a Government agency for the conservation and development of the fisheries of Bengal. He suggests a constitution after the model of the Scottish Fisheries Board, a salaried Commissioner and an Advisory Board of six honorary members. The work of the Fishery Department of Canada furnishes the nearest parallel to what will be expected of the new department in Bengal; but in the latter case the Government will have to do more, as it will have to create and build up the sea-fishing industry, with the object of handing it at no distant date to private enterprise. Hatcheries and breeding ponds will have to be opened, foreign varieties will have to be introduced by acclimatisation and transplanting and scientific research in all its various branches will have to be set on foot and encouraged. The whole report is now believed to be receiving the careful consideration of Government.

CHINESE VEGETABLE TALLOW.

The vegetable tallow tree, known to the local Chinese as the "Mu-Tze-Shu," is found in the mountainous and hilly sections of the province of Hankow. The trees grow in large numbers through the valleys in a semi-rocky soil, and on the mountain sides to an altitude of 2,500 feet. The tree, according to the American Consul at Hankow, is of medium size, with heart-shaped leaves which turn a brilliant red in the autumn. The seed pods are seen in abundance on the small branches of the tree, and contain three seeds about the size of a coffee bean, greyish-white in colour. As the autumn advances the pods dry up, exposing a cluster of three seeds. These are picked during November, and at once stemmed and made ready for use. They are steamed, and the white exterior of the seed, which is the vegetable tallow, or "Pi-yiu," is thus removed. A small brown seed remains, which is ground in the Chinese millstone, boiled, made into cakes, and placed in a press, and a light brown oil extracted from the kernel. This oil is known as "Tze-yiu" or vegetable tallow-seed oil, and is used by the natives as a burning oil, and also for adulterating other more valuable oils. The refuse is used as a fertiliser. The tallow is collected, melted, and put into large tubs, which serve as a mould. Blocks of wood are put into each cake, to which ropes are attached and serve as handles. In this form it is brought to the market at Hankow. The seeds, as first picked, yield in weight about twenty-eight per cent. of vegetable tallow, and about 40 per cent. "Tze-yiu." The vegetable tallow sells in the market at from twenty-seven and sixpence to thirty shillings per "picul" of 133 pounds, and the vegetable tallow-seed oil at twenty-five shillings per "picul" of 133 pounds, very small quantities, however, of the latter oil being brought to Hankow, as none is exported. The vegetable tallow is used by the Chinese principally in the manufacture of candles, it being of greater consistency than the other oils used for the purpose, and only a small quantity of the white wax is needed. The vegetable tallow industry of Hankow is one of considerable extent, most of the tallow being shipped to Europe. None has been exported to the United States since the early part of 1906, and that consignment was made as a sample. The tallow is said to mix readily, and European firms find use for large quantities in the manufacture of soaps and candles. Great care must be exercised in buying it in Hankow, as much of it is adulterated by the addition of water and other oils, and most of the Hankow shippers have found it necessary to re-melt all the tallow in the presence of the native seller, and so remove any foreign matter. During 1905, according to the customs returns, twenty million pounds were exported from Hankow, while in 1906 the amount increased to twenty-seven million pounds. Up to November 15, 1907, nearly twenty-seven million pounds had been exported.

ARTS AND CRAFTS.

The Franco-British Exhibition.—The plan of the Franco-British Exhibition—with its Palace of Decorative Arts as well as two buildings devoted to the Applied Arts and another two to Industrial Art, to say nothing of the Palace of Women's Work—promises so much to look at in the way of Arts and Crafts that, at the first blush, one is somewhat badly disappointed with what there is really to be seen. The Decorative Art Section proves on examination to include, amongst other things, billiard tables, cooking stoves, and safes, which hardly seem to come under the heading either of decoration or of art. Then the applied and industrial arts, so-called, do not, for the most part, seem to go far beyond the merest manufacture.

This first impression is, however, a trifle deceptive. To begin with, there are a few very interesting exhibits in the Decorative Art Palace; and when one has patiently gone through the rather heterogeneous collection of exhibits included in the Women's Section one finds that here, too, are some things to be seen which are interesting from the point of view of Arts and Crafts. Further, the British Education Section includes a really large amount of art work, some good, some bad, but nearly all of some interest. Finally, when once we have discovered the Pavilion André Délieux, at the rear of the French Restaurant, we realise that here we have a really representative little show of the work being done at the present day by some of the best French artist-craftsmen and architects. It is really a pity that exhibits of this character are so scattered as to make it difficult to find them, and all but impossible to compare them one with another. In fact it produces the impression that (apart from Fine Art) there is very little artistic work to be seen, whereas in reality there is a very fair quantity.

Pottery.—The pottery is, perhaps, more scattered than any of the other exhibits. There are eight good-sized English stands in the Palace of Decorative Art; while one English firm shows in the Women's Section—apparently on the rather insufficient plea that the pieces exhibited are finished and glazed by women. The French trade work is shown for some occult reason in the Machine Gallery, and the French artist potters exhibit in the Pavilion André Délieux, as well as providing a few pieces to be shown as *objets d'art* in the floor cases of the French picture galleries. It is noteworthy that Sèvres and other large French manufactories are not represented at all. There are some fairly interesting pieces of French stoneware by Delaherche and others. The little collection of *pâte-tendre* of Naudon, carefully arranged to show the translucent character of the glaze—which fills in the tiny apertures cut in the solid body for its reception, is really beautiful in colour and in general effect. Sprigs of mimosa and other small flowers, appearing like jewels embedded in the white body, have a very happy effect when they are seen with the light shining through them. This kind of work is

beautifully delicate, and shows a very high degree of technical skill on the part of the maker. M. Taxile Doat, of Sèvres, sends a fair sized collection, which includes both stoneware and porcelain. Some of his lustred crystalline glazes are both interesting and beautiful. It is something new to find an effect of lustre added to crystalline glaze, and it is a novelty which, as seen in the Collectivité André Délieux, at any rate, is entirely satisfactory. M. Doat's figure work, quite cameo-like in quality, is also well worth notice.

The large English pottery and tile making firms have for the most part, like their French *confrères* abstained from exhibiting. There are, however, two notable exceptions in the shape of the Worcester Works and the Pilkington Tile and Pottery Co. Worcester has a large show, but it has contented itself with showing the kind of work it has been turning out for a good many years past. There is nothing very striking about their exhibit. It is more like a shop show-room than anything else. The Pilkington Tile and Pottery Co., on the other hand, have erected an architectural structure, on the outside and inside walls of which they display various types of tiles—while several large show cases contain specimens of their lustre and Lancastrian pottery. The lustre tiles of the fireplace opposite the entrance are what first catch the eye, but it is soon carried up to the blue tiling of the flat dome—broken here and there with fillets of silver lustre. The outside walls are covered with a simple pattern in hard vitreous tiles, while the inner ones are decorated with large panels of tiles designed so as to be largely reminiscent of Persian work. They are of bold design, in which rich blue and green predominate, relieved with just touches of Rhodian red in places. The decoration of the walls is both striking at first sight and satisfactory on closer acquaintance, and yet it is not in the architectural work but in the vases, more especially the lustred ware, that the great attraction of the exhibit lies. Fine lustre pots have been exhibited before now by the Pilkington Tile and Pottery Company both in London and elsewhere, but their exhibit at the Franco-British Exhibition quite eclipses the shows which have gone before both in the quality and the variety of work shown. The makers have not been content with getting accidental effects irrespective of form or pattern. Practically all the lustre vases are painted, some with elaborate figure subjects like the large vivid blue vase adorned with "the ride of the Valkyries," others with quite simple pattern work. There is one large vase which owes a good deal of its attractiveness to the massive flutings which divide it into panels of convenient size for ornament, and also give the lustre an opportunity of catching the light at various angles. Again, the charm of some quite tiny pieces is due to the moulded beasts, which crawl Chinese fashion about their necks or handles and afford excellent opportunity for the display of the beauties of the glaze. In addition to the fine yellows and reds which one has learnt to expect in copper and silver lustre, there are lustred vases in a fine juicy blue, which has covered the surface of the body rather unevenly, and is in consequence not all of one dead even tint. The latest achievement, however, is the production of a fine brilliant green, neither crude nor dull, which harmonises beautifully with the pearly tones of the lustred patterns upon it.

Leatherwork.—There is so much amateurish leatherwork about in England at the present time, that what is shown at the Franco-British Exhibition comes as somewhat of a relief. This is especially the case with the French work, of which a fair quantity is shown both in the Pavilion André Délieux and in the Fine Art Section. There is, however, some workmanlike English leatherwork to be seen, notably the exhibit from Leighton Buzzard, in the Women's Section, where some interesting lacquered leather is shown. This, by the way, is much more satisfactory in colour than the painted work exhibited by the same class at the recent exhibition of the Home Arts and Industries Association. The English book-covers shown are some of them pleasant in design and adequate in workmanship, but there is nothing peculiarly fresh about them on the whole. When we turn to the French work we find amongst the exhibits in the Fine Art Section some rather interesting leather inlay on a peculiarly large scale. On the whole, however, the most interesting leatherwork is to be seen in the Pavilion Délieux, where, too, the pieces are for the most part labelled, so that he who runs may read the name of the artist responsible for the work. Amongst other interesting pieces of work may be noted the dainty little sandal shoes in cut and embossed leather and the trimming for a child's frock to match, which is applied to a straw-coloured satin ground with very satisfactory results. There are also (shown in the same case) some pretty and workmanlike leather belts decorated with little metal rivets—or more probably with narrow metal tapes run in and out, it is difficult to tell which. The embossed and cut book-covers of M. Nicholas A. Ralli are also fairly satisfactory in design and very good in workmanship. These are shown in another case. In still another there is a cunning little leather bag decorated with a figure subject in cut and embossed work in a very masterly way. This is peculiarly satisfactory from the point of view of colour. It seems to be the custom in France to use leather of a darker tint than is usually employed in England; and, starting from this darker ground, it is only natural to employ less light and less delicate colours upon it than the English workers commonly adopt when working on a paler ground. The effect, for the time being, is certainly more satisfactory, though it is impossible entirely to repress a feeling that, when time has somewhat dulled these heavy tints they may look dead and dingy. There is wisdom, perhaps, in working on a material which, though it may look a little raw for the moment, will mature and improve as time goes on.

GENERAL NOTES.

Russian Coal.—The Russian coal trade, which a few years ago was negligible, is now showing signs of rapid development, and supplies have found their way to the capital. Last year was the first year in which such supplies were recorded, the quantity of coal brought from St. Petersburg from the Donatz and Dombrova districts being 17,225 tons. The output in the south of Russia during the first ten months of 1907 is said to have amounted to 11,868,548 tons of coal and 1,614,677 tons anthracite, which exceeds the quantity given for the corresponding period of the previous year by 1,733,870 tons. In his report on the trade of Russia, just issued (Cd. 3727-49), Mr. Vice-Consul Mackie says that it has been found from experiments with the native product, carried out at St. Petersburg, that briquettes made from this coal are suitable for use in the Navy and on the railways, and proposals have been made to establish two briquette factories, one at Mariapol, capable of supplying the north-west of Russia, and another at Odessa for supplying the railways in the south. Considerable quantities of coal raised in Russia have already been exported, and enquiries are said to be continually received from foreign countries for prices and conditions of supply of Russian coal. As soon as the manufacture of coal briquettes can be established on a large scale in the Donatz basin, this district is expected, says Mr. Mackie, to be capable of supplying distant markets and of competing with the best fuel from other sources.

New Caledonia.—Mr. Acting-Consul Maning's report on the trade of New Caledonia for last year (Annual Series, No. 3971) is a depressing description of the state of affairs in the island. The population of the whole country is said to comprise some 53,000 persons, of whom 13,000 are free, and 11,000 of convict origin, the rest, about 29,000, being black. In the past, sugar mills, meat preserving works, flour mill and smelting works, existed in the island, but these have each in their turn disappeared, and the only semblance of local industries to be found to-day, are a small pearl-button factory and a meat-canning depôt, all the others having ceased to exist. The backbone of the colony's wealth is in its vast mineral deposits, now very imperfectly worked, but the nickel and chrome mines are still finding large quantities of ore, and it is said that 1908 is likely to see another large syndicate, worked by British capital, engaged in the nickel industry. The Canadian cobalt discoveries have done considerable damage to the New Caledonia product, and cobalt ores of 4 per cent. are not worth more than £3 10s. to £3 12s. per metric ton, the price rising to £8 5s. for 6 per cent. The loss of a market for this mineral is a great blow to the colony. Experiments are being made in cotton and cacao cultivation, but rubber exports have almost ceased. There being no protection of the trees, they are bled to death by the natives, and Mr. Maning predicts that "in a short time rubber will be an unknown commodity as far as local trade is concerned."

Cotton in the Society Islands.—Some of the Society Islands are remarkably propitious to cottons of all kinds, and especially the Sea Island variety. The local administration have spared no pains to impress the desirability of this cultivation upon the owners of the land, the acting Governor having, on several occasions, personally undertaken crusades of propaganda round the island distributing gratuitously seeds of the best Sea Island cotton, specially imported by the Government for the purpose. But it may be gathered from Mr. Consul Simons' report (No. 4010, Annual Series), that his efforts have been attended by only partial success. Out of about 370 acres which it was expected would be planted in Sea Island cotton, as a result of these efforts, it is believed that not more than 50 acres have actually been put under cultivation. Sea Island cotton requires a careful preparation of the soil before and much care after planting, and the native prefers the Egyptian variety, common in the island, which entails little labour. Whereas the Sea Island variety requires to be replanted every year, the Egyptian bears for five or even ten years without requiring any attention after the first few months, and yields in quantity returns that are so far in excess of the Sea Island that even the higher price of the latter can afford no inducement to the agriculturist.

Polish Industries and Labour Disputes.—The effect of the labour troubles of recent years upon Polish industries is shown in Mr. Acting-Consul St. Clair's report on the trade and industries of Poland just issued (No. 3988, Annual Series). In 1904 there were in Warsaw 452 factories employing 49,000 men and producing goods to the value of £8,200,000. In 1905, the so-called strike year, the total industrial output declined by £1,000,000, and in 1906 and 1907 by another £1,000,000. In Warsaw especially, the leather industry, the manufacture of agricultural machines, and breweries, were developing before the strikes. For instance, the value of the production of leather in 1873 was £300,000; in 1903 it was £600,000. The steam-engine and agricultural machinery works produced some years before 1873 goods to the value of £250,000, while in 1903 the value was £500,000. Breweries in former years gave a total production valued at £125,000, in 1903 the output was valued at £400,000. Lodz in 1904 had 493 factories employing 64,000 men, and the value of their output was estimated at £12,500,000. In 1905 it had declined to £10,900,000, and in view of the continual labour troubles of the last two years the Acting-Consul thinks that it has declined at least £1,600,000 more. So with other trade centres:—At Sosnowice, the total value of production since 1905 has fallen from £2,650,000 to £1,950,000. At Czenstochowa from £1,100,000 to £950,000. At Zgierz from £470,000 to £350,000.

Journal of the Royal Society of Arts

No. 2,903. VOL. LVI.

FRIDAY, JULY 10, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday, 6th inst., at their first meeting, the Council elected Sir William White, K.C.B., F.R.S., LL.D., D.Sc., as Chairman for the ensuing year.

CONVERSAZIONE.

The Society's annual conversazione was held at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Thursday evening, 2nd inst. The reception was held in the Central Hall of the Museum, by Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., Chairman, and the following members of the late and present Councils:—Sir William Abney, K.C.B., F.R.S., Sir William Bousfield, M.A., LL.D., Major - General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., Arthur Charles Claudet, Sir William Crookes, D.Sc., F.R.S., Robert Kaye Gray, Colonel Sir Thomas Hungerford Holditch, R.E., K.C.M.G., C.B., Sir John Cameron Lamb, C.B., Sir Philip Magnus, M.P., the Hon. Richard Clere Parsons, M.A., Sir Boverton Redwood, D.Sc., Sir Owen Roberts, M.A., D.C.L., Alexander Siemens, Professor John Millar Thomson, LL.D., F.R.S., Sir William Hood Treacher, K.C.M.G.

The following portions of the Museum were open:—The Central Hall, the North Hall, the Bird Gallery, the Reptile Gallery, and the East and West Corridors on the first floor.

Concerts were given by the String Band of the Royal Regiment of Artillery (conductor Mr. E. C. Stretton) in the Central Hall, and by Mr. Harry Tipper in the Reptilia Gallery. A selection of songs, instrumental music, &c., was performed on the Auxeto-Gramophone under the direction of the Gramophone Company.

The number of visitors attending the Conversazione was 1,453.

PRACTICAL EXAMINATIONS IN MUSIC.

The practical examinations in Music were not concluded this year until the 4th July, too late for the results to be included in the Report of the Council. They lasted for 10 days.

The examination was conducted by Dr. Ernest Walker, M.A., and Mr. Burnham Horner.

The system of examination was the same as that for recent years. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play or sing a piece, or portion of a piece, at sight, and to play certain scales.

In all, 440 candidates entered, and of these 432 were examined, a decrease of 25 as compared with the last year. There were 333 passes and 99 failures.

The following were the subjects taken up:—Piano, singing, violin, violoncello, and viola. 330 entered for the piano, 243 of whom passed; 86 entered for the violin, of whom 76 passed; 2 entered and passed for the violoncello; 12 entered for singing, of whom 10 passed; and 2 entered and passed for the viola. Two medals were awarded.

The examiners report that in certain respects the general level of attainment was perhaps slightly higher than last year. They would, however, continue to urge upon teachers the vital importance, in every department, of attention to quality of tone: accuracy and steadiness will not, if the actual sound produced is disagreeable, carry a performer more than a very limited distance.

MAHOGANY.

By Frank Tiffany.

Of the many and varied products of the tropical forest probably none possess a greater range of economic utility or stand so high in popular estimation as this wood. Its appreciation is attested by the following facts, that in 1753 we received in England from the island of Jamaica 521,300 feet, "board measure," that is 1 foot long by 1 inch thick, and 12 inches wide. In 1842 the imports of mahogany into Liverpool were about 1,220,000 feet, prior to the repeal of the timber duties, but after the repeal in 1845 the imports were 5,220,000 feet, and in 1907 the imports amounted to the enormous total of 25,462,000 feet into Liverpool alone.

There are four species of mahogany:—

First. *Mahogani Swietenia*—the general mahogany of commerce—named after the celebrated Baron Swieten, physician to Maria Theresa.

Second. *Soymida febrifuga*, or East Indian mahogany, a tree attaining to an enormous size in Central Hindustan, with a lofty straight trunk, covered with a grey scabrous bark; branches numerous, the lower ones spreading, the upper ascending; leaves alternate, abruptly pinnate, about a foot long. The wood lacks the colour of the ordinary mahogany, and as yet it has not entered largely into our commercial economy.

Third. *S. Chloroxylon*, otherwise *Chloroxylon Swietenia*, found chiefly in Bengal; it does not vary materially in its general character from species Nos. 1 and 2, but the tree is not so large, and the wood is of deep yellow colour, similar to boxwood, but lacks its density.

The fourth species, known as *Khaya Senegalensis*, is found on the West Coast of Africa. Although botanists class it as a distinct species, practical men regard the best African shipments as being essentially the same as the mahogany found in the Gulf of Mexico—especially in structure and fibre. Much of the wood from Africa is extremely fine, both in texture, colour, and figure; possibly that from Benin and Lagos is the best.

The meaning of the word "mahogany" is an enigma, and this is the more remarkable when it is considered that the wood is of comparatively recent introduction. There is no work extant which explains its derivation, nor has any proper etymological explanation of it ever been advanced.

It is curious to note the variations in the spelling of the word, now distinctly "mahogany," but the printed pedigree is as follows:—1671, Colgelly's "America," page 338, "mahoganey;" 1703, the *London Gazette*, "mahogony;" 1733, Brampton's "Man of Taste," "mahogena;" 1762, Linnæus (Botanical Latin), "mahogani;" 1817, Lord Byron in his "Beppo," "mahogany."

The word may possibly be of Aztec origin, "mahogane," seeing that the wood was first found in Central America. It is possible that the "cedar," largely employed in the building of Solomon's temple, may have been mahogany, and it should be noted that the early Spanish voyagers misnamed "mahogany" as "cedar." Whilst it is true there is a resemblance betwixt the two different woods, it cannot be too distinctly stated that their differences are clear and distinct. Mahogany is technically a hard wood, whilst botanists rightly class the "cedrela" as a soft wood, although its capsules are nearly alike, but smaller than those of mahogany. To attempt to explain why one wood is recognised as a hard wood, and others as soft, hardly comes within the purview of our present consideration, but it may be stated that certain hard woods are actually of a softer nature than others which are known as soft woods.

The following are the botanical characteristics of mahogany:—Natural family Meliaceæ; its essential characteristics are, calyx 5 cleft, petals nearly cylindrical, bearing the stamens at its orifice; capsule 5 celled; woody opening at the base, many seeds, intricate, compressed, oblong, with a leafy wing; leaves, pinnate, reclining, alternate, shining, numerous on the younger branches; leaflets mostly in four pairs, often three, but seldom five, without an odd one; lanceolate, quite entire, opposite, 1½ inch long, stalked, panicles corymbose, with about eight flowers on each; small, whitish, occasionally of a reddish or saffron colour.

The Mahogany Tree is one of the most beautiful and majestic of trees, with a trunk often 50 feet in height and 12 feet in diameter, which divides into many huge arms, throwing the shade of the shining green leaves over a vast extent of surface, so that a more magnificent or beautiful object is not to be found in the vegetable world. The mahogany forest does not on an average yield over two trees to the acre of ground.

Swietenia Mahogani is indigenous to the

islands of the Caribbean Sea, the mainland of Central America, and the West Coast of Africa (the latter yielding the greatest supplies to the British market). Mahogany grows in its greatest perfection in the parallels comprised in latitudes of 11° to 23° 10′ North.

Whilst botanically this class of mahogany is all the same, the trade divides it into classes, and it would be difficult to convey to the lay reader the intrinsic differences of the various shipments, but, to the expert, they are most marked. We have thus—the City St. Domingo mahogany, St. Domingo (Puerto Plata north side wood), Cuba mahogany, Honduras, Tabasco, and Minatittan mahogany. Then the African shipments are further classified, as Axim, Assinee, Benin, Lagos, &c.

Space, however, prevents an attempt to explain the various characteristics of the different consignments, beyond saying that those from St. Domingo and Cuba have a distinct charm, possessing, as they do in a marked degree, those essential chemical constituents which age mellows, and their firm silky texture gives them a *prestige* over other shipments. These technically are known as Spanish mahogany; generally they lack the size of the wood classed as "baywood," (this is an abbreviation of "Honduras bay"). The actual Belize wood is of a superior character, but the term, "bay-wood" is now commonly applied to other shipments from the mainland.

The precise period which a mahogany tree takes to attain full growth is not accurately known, but when large it changes little during the life of a man, and it is estimated that the time required to arrive at maturity is probably not less than 200 years.

Mahogany Commercially.—Having briefly outlined the botanical features of the mahogany tree, a few of its characteristics as a wood along with its special adaptability as an aid to constructive and decorative art may be of interest. In the limited space at disposal it is difficult to set forth all the salient features of a wood which is uudoubtedly the premier product of the tropical forest, and its economic utility is so wide that justice cannot be done to the subject.

In attempting the work, the object must necessarily be to lay before the uninitiated a few primary facts rather than to teach the expert, and the order in which the facts are set forth are not meant to imply that they are in their proper sequence; and it is also possible that important considerations may even be omitted.

To the connoisseur mahogany possesses a beauty of appearance when of fine colour and richly figured, but extreme colour becomes a blemish, especially if the texture is not good. Another important and almost unique feature is that this wood with age mellows in appearance and attains a bloom of colour not evident when newly wrought. Possibly, with the exception of oak, it is the only wood possessing this trait. Rosewood and Padouk when made up and newly polished, have a charming appearance, but with age the colour fades, and the wood assumes a listless or dead appearance. Whether to place figure in mahogany before its colour is a point upon which experts may differ, but either in themselves make a log valuable; but, whilst nature is prolific, it is seldom that the combination of figure, colour, and texture is found in one log. Where these three factors are blended they form a beauty much to be admired, and give a value to a log ranging from 2s. 6d. to 30s. per foot, whilst the cargo average may only be from 4d. to 6d. It will be understood that where logs realise the high prices stated they are used in veneer form, whilst the cheaper wood is used in the solid.

Plain mahogany has a utility peculiarly its own, and its uses are almost illimitable; for ordinary furniture and for painting and enamelling it is without a compeer.

Size.—Whilst the uses of many fancy woods are limited by their small sizes, mahogany stands out as a wood giving either extreme length or width, or both combined; hence for signs, facia boards, counter-tops, and panels for railway carriages, it is unrivalled. Sometimes it is of hard texture, and in other cases of a mellow nature, making it suitable for carriage panels. Then mahogany, even when figured, does not possess that alternate hardness and softness of grain characteristic of many woods, which makes it so difficult to obtain an even surface on them in highly-finished work. Some woods, whose initial cost may be low priced, yet in their manipulation, after all the care possible has been spent upon them, show a ridgy face and lack a fine even surface, owing to their absorbent nature and uneven fibre; they will not compare in beauty even with an ordinary grade of mahogany.

Warping and Twisting.—The great desideratum in high-class woodwork, if the cost of the labour is to be justified, is to use a wood which when wrought will stand—that is, neither warp, twist, or shrink. Many fancy woods, even when reasonably seasoned, have

these failings, but in mahogany they are absent in a marked degree; it can also be readily seasoned.

The Cost.—Of all the furniture-woods available, if we except the few specially-figured logs, the average cost of mahogany is lower than that of many of its rivals, it is also less wasteful in conversion.

History.—The first mention of mahogany occurs shortly after the discovery of America, when Cortez, between the years 1521 and 1540, employed it in the construction of the ships used for prosecuting his voyages of discovery. After the conquest of Mexico, Sir Walter Raleigh, in 1527, used it for repairing his vessels. Captain Dampier mentions it in 1681, but called it "cedrela." In St. Pierre's "Studies of Nature" it is stated that mahogany grows on the shores of the Antilles. Catesby's "Natural History," 1754, speaks of the excellence of mahogany for all purposes. As to its first introduction into this country, some doubt appears to exist, and it is claimed by a firm of cabinetmakers, that their predecessors, Messrs. Gillow, imported a cargo during the reign of Charles I., who died in 1649; this, however, clashes with the account given in Lunan's "Hortus Jamaicensis," which states that it was first imported into England in 1724, and relates how a few planks were sent to Dr. Gibbons, of London, by a brother, a West Indian captain. The former was erecting a house in Covent-garden, and gave some mahogany to the workmen, who rejected it as being too hard. Then Wollaston made a candle-box of it, which outshone all the doctor's other furniture, and became an object of curiosity and of exhibition. Finally, some was made into a bureau for the Duchess of Buckingham. Certainly Lunan's account is well authenticated.

At this day it would be difficult to decide the rival claims as to the first introduction of mahogany, but it has certainly since then gained a prestige not exceeded by any wood, and its adaptability as an aid to constructive and decorative art is undoubted.

Mahogany Forests. — It will be understood, that as mahogany grows in the tropical forests, where there are no roads, and, further, there exists an excessive amount of undergrowth of brushwood, which must be cleared, hillocks cut away, hollows filled, and bridges made, to get the logs to the nearest waterway, and the transportation of logs weighing from one to ten tons becomes a serious difficuly in the absence of mechanical appliances. In Honduras, the season for cutting commences about August. After sufficient trees have been cut, the roads are then formed; cross-cutting is then commenced; by the month of March, which is the dry season, the hauling commences. This can only be done in the month of April, as the ground at other times is too sodden to permit the removal of such heavy weights. Then, if what should be the dry period proves to be wet, the logs may be hung up for a year, and in that time many become unfit for shipment. Assuming that the logs are got to the waterways ready for the rainy season, May-June, then if all goes well, the rivers rise sufficiently to enable the logs to be floated. But here, again, disappointments are frequently in store, and the logs become stranded.

In Cuba the logs are cut throughout the year, but more particularly from October to June. When they are prepared, they are drawn by oxen to the edges of the forest; they are then loaded on carts to the river. When sent down to the river the logs are tied together, but at the rapids they are separated; after clearing the rapids they are formed into rafts.

Supposing that the logs are successfully negotiated through all the difficulties, from the point of growth, to and through the rivers, to the lagoons. Here another danger awaits them—the rivers are fresh water, and the sea-water, salt—but the lagoons are brackish waters, and in these are to be found the "teredos," which cannot exist either in fresh or salt water. Should the logs arrive in the lagoons, and there is no vessel at hand to receive them, then, in a few days, it is possible that the logs will become thoroughly honey-combed by the "teredos." A few years ago, thousands of logs were landed in Liverpool, which were not worth freight and charges. So it will be seen how extremely speculative it is to undertake the exportation of mahogany.

The African mahogany trade is quite a new development since 1890, and it has attained gigantic proportions; for all practical purposes, its difficulties are identical with those set forth in relation to Honduras and Cuba. The tree however is different, *Khaya senegalensis*, and not a *Swietenia*. In Africa they have their labour troubles, and it is now difficult to get the blacks to engage in the mahogany trade, as mining, &c., offers better pay, and the work is more permanent.

It is generally admitted that the value of all

timbers are appreciating; and in the near future it will be found that the value of mahogany will be seriously enhanced.

THE GERMAN COTTON INDUSTRY.

In the manufacture of cotton goods, Germany holds third place, being only exceeded by the United Kingdom and the United States. In the exports of cotton goods, Germany is only exceeded by the United Kingdom. Raw cotton is the largest single import of Germany, and manufactured cotton the largest export. In 1907, the imports of raw cotton amounted to 934,000,000 pounds, valued at £23,000,000, and the exports of cotton manufactures amounted to 152,000,000 pounds, valued at £20,200,000. Cotton manufacturing is an old industry in Germany, and before the introduction of machinery, there were well-known centres of weaving, knitting, braiding, lace-making, &c., in Saxony, and on the Rhine. The German people were slow to avail themselves of the introduction of modern machinery, so that many local hand industries were stifled by the flood of machine-made goods from other countries, and, for a long time, Germany obtained the bulk of her cotton goods abroad, mainly from England. The unification of the German Empire in 1870 awakened the national spirit, and encouraged by a firm central Government there began an agitation for the manufacture of cotton goods at home. The 1,500,000 spindles taken over with Alsace-Lorraine, put the German industry ahead of the French, and this lead was further widened by the increased momentum in the cotton manufacturing industry, about 1879. Since then there has been no very remarkable developments, but a gradual and steady growth. The American Special Agent in Germany who has been commissioned to enquire and report upon the cotton industry in that country, says that the rate of growth in the different districts has not been the same. Saxony is the leading German State in cotton manufacturing, and has nearly trebled its spindles in the last twenty years, but its increase has been even greater in special lines, such as knitting and embroidering. The State that has shown the most remarkable progress is Westphalia, which had nearly seven times as many spindles in 1907 as it had in 1887. That part of Hanover near the cotton centre in Northern Westphalia, shows a large comparative increase, and so does Wurtemberg, both of these having more than doubled their number of spindles. Bavaria and the Rhine Provinces also show substantial increases; Alsace a very slight increase. The Alsatian mills, however, have advanced further than the others in the direction of fine goods, which can be seen from the fact that while there is an increase of 10 per cent. in the number of spindles, there has been a 4 per cent. decrease in their consumption of cotton.

The following statistics furnished by the Bremen Cotton Bourse show the number of spindles, and the amount of cotton consumed in the several kingdoms and provinces of Germany in 1887 and 1905:—

Kingdoms and Provinces.	1887.		1905.	
	Spindles.	Cotton Consumed.	Spindles.	Cotton Consumed.
	Number.	Bales.	Number.	Bales.
Saxony	541,122	90,505	1,321,288	225,000
Saxony, Vignogne spinning	460,447	102,200	628,025	163,085
Bavaria	924,312	161,516	1,578,084	300,000
Alsace Lorraine	1,375,000	250,000	1,511,586	240,000
Westphalia	285,828	59,500	1,172,222	255,300
Rhine Province	435,802	165,580	1,051,362	287,090
Wurtemberg	354,548	54,390	706,585	115,000
Baden	398,172	58,562	468,784	80,134
Hanover	105,000	18,350	211,740	48,425
Silesia	75,064	21,500	109,320	28,315
All others	99,500	24,880	73,020	19,020
Total	5,054,795	1,006,983	8,832,016	1,761,369

German cotton manufacturing is more scattered than the English, Swiss, Italian, or East Indian, but there are three well defined centres—the Saxon, the Alsatian, and the Westphalian. The first section lies north of the mountains of Northern Bohemia, and consists of the Kingdom of Saxony and the Upper Franconia Province of Bohemia. In regard to general cotton manufacturing, including not only spinning and weaving, but knitting, embroidering, lace-making, cotton-waste manufacture, artificial flowers, &c., it is the most important section of Germany. It contains some 3,000,000 spindles, and its most important towns are Hof, Bayreuth, and Bamberg, in Upper Franconia; and Chemnitz, Mitturida, Plauen, Werdau, Zittau, and Zwickau, in Saxony. The second section lies in the extreme south-west corner of Germany, between the cotton manufacturing districts of Eastern France, Switzerland and the Austrian Vorarlberg, and contains some 4,000,000 spindles unequally distributed between Alsace, Baden, Wurtemberg, and Bavarian Swabia. The main cotton-manufacturing towns are Mülhausen, Gebweiler, and Logelbach, in Alsace; Augsberg and Kempten, in Bavaria; Unterhausen in Wurtemberg, and Lörrach in Baden. The third section lies in the north-west corners of the Prussian Rhine and Westphalian provinces, and has 2,500,000 spindles. The main centres are Gronau, Bocholt, Rheine and Epe in Westphalia, and Rheydt and München-Gladbach in the Rhine Province. There are in Germany 21 towns having more than 100,000 spindles each, and these towns united have more than half the spindles in Germany. The weaving industry is more scattered, and there are more than 50 towns with more than 1,000 looms each. Mülhausen in Alsace is the most important town in Germany as regards spindles and looms. Nowhere in Germany is the cotton industry better organised than

at Mülhausen, and that place has become noted for its fine muslins and print goods. Having a large local trade, Mülhausen is not a great export centre, although it ships some fine bleached goods and fine prints to the neighbouring districts of France, and supplies muslins for St. Gall embroiderers. Mills are scattered throughout the country round Mülhausen. Besides Mülhausen, the other two large textile centres of Alsace are Gebweiler and Logelbach, though there are a score or more of smaller towns of more or less importance clustered in this vicinity. Next to Mülhausen, the largest cotton-mill town is Augsberg, in Bavaria. This is one of the important towns of South Germany. It has a population of about 95,000, and lies at the junction of the Wertach and Lech rivers, 38 miles north-west of Munich. Contrary to the custom of Mülhausen, where practically no water-power is used, the Augsberg mills are run mainly by water-power. Canals traverse the town, and the mills are situated on these canals on the outskirts of the town. Gronau, in Westphalia, has only six mills and is a little village of only 8,500 inhabitants, but it is the third largest cotton-mill town in Germany. This is mainly due to the fact that the largest cotton-spinning mill is established here. One of the densest cotton-mill centres is that made by three close neighbours, Rheydt, München-Gladbach, and Mulfort, in the Rhine Province. These three towns, of 40,000, 60,000, and 8,000 inhabitants respectively, have 719,037 spinning spindles, 75,000 twister spindles, and 12,914 looms. Chemnitz stands twelfth in number of spindles, but is one of the most important cotton manufacturing towns in Germany. Its importance is due to the fact that it is the centre of the German knit goods manufacturing industry. Plauen is a town with no spinning and few looms, but it is an important cotton manufacturing centre, owing to its lace and embroidery work. Very little machine-made lace is made in Germany, but the largest factory of this kind is at Dresden. Exeept for this, and for the manufacture of artificial flowers, Dresden is not important as a cotton manufacturing centre. Werdau and Crimmitschau, in Western Saxony, are important as being the centre of the large Vigogne yarn spinning business. Barmen, in the Rhine Province, is noted for its braided work, and for its manufactures on the ribbon loom. Crefeld is noted for its velvet manufacture and velvet dyeing, München-Gladbach for its coloured goods, &c. Comparatively few of the German mills have both spindles and looms, and in the large centres the mills specialise as either spinning or weaving. The more remote mills in the country districts of Alsace and the Rhine usually weave their own yarns. The President of the German section of the International Federation of Master Cotton Spinners and Manufacturers's Association estimates that on March 1, 1908, there were in Germany 9,592,855 spindles in operation, and 455,946 being installed, or a total of 10,048,801, but it is considered that these figures are rather under than over estimated. There are twelve cotton mills in Germany, with over 100,000 spindles each, and two of these have each over 200,000 spindles; five mills have more than 2,000 looms each, and thirty-five have more than 1,000 looms each. The majority of the German cotton mills are run by private companies. The most recent figures show that of the spinning mills 75 per cent. are private companies, also 66 per cent. of the combined spinning and weaving mills, and 98 per cent. of the weaving mills. Bavaria, which has the largest mills, also has the largest percentage of incorporated stock companies —in fact the majority of the Bavarian spinning mills are stock companies. In Westphalia, on the Rhine, and in Saxony, nearly all the mills belong to private companies. The weaving mills in Bavaria, as well as elsewhere, are practically all private companies.

OUTPUT OF COAL MINERS.

The past twenty years have witnessed a considerable expansion in the production of coal in the United Kingdom, although the development has been both absolutely and relatively less than that which has taken place in the United States. During the past decade the progress in the British tonnage raised to the surface has been almost continuous, only two years having experienced a temporary check, and this was removed in the following years. The aggregate production of coal in 1907 amounted to 267,000,000 tons, or over 16,000,000 tons in excess of the output in the preceding year, and nearly one-fourth of the former quantity was shipped to other countries. Notwithstanding the phenomenal figures for last year the demand for exportation has been well sustained, in so far as the present year is concerned, seeing that the Board of Trade returns for the first five months actually indicate a not inconsiderable ncrease as compared with the equivalent period in 1907. It has, of course, not been possible to deal with the larger output last year without further drawing upon the labour market. In this connection the general report and statistics of Mines and Quarries for 1907 show that the number of miners employed both underground and on the surface totalled 940,000 as contrasted with 882,000 in 1906. These figures represent the formidable addition of 58,000 workers in a single year, and we look in vain for a single augmentation in any preceding twelve months. All the producing districts participated in the increase in the output in 1907, the Midlands coming first with the largest increment, Yorkshire and Lancashire ranking second, and the East of Scotland occupying the third position from this particular point of view.

It was given in evidence before the Departmental Committee on the Miners' Eight Hours Day that the estimated loss in production by the intro-

duction of the system would amount to 25,000,000 tons per annum, calculated on the output in 1906. Although the committee declined to accept this conclusion as put forward by witnesses engaged in the management of collieries, they admitted that some diminution in the quantity of coal raised to the surface would follow a statutory reduction in the number of working hours, whether introduced gradually or suddenly. But if it be assumed that the coalowners are correct, and that the effect would be a curtailment of the tonnage of coal to the extent indicated, the question arises as to what would have to be done under the circumstances. It would obviously be impossible for the country to be deprived of the use of such a considerable quantity of coal, and it would, therefore, either be necessary to prevail upon the miners to work harder or to procure a large supply of additional labour. The idea that the men would produce a greater tonnage of coal individually may be dismissed from consideration on the ground that the tendency in the coal trade, as in other industries, is to do less work and not more. It would consequently be essential to make a large addition to the ranks of the miners, and a simple computation shows that a fresh army of 85,000 men would be required to maintain the output of 25,000,000 tons, provided, of course, that the assumed reduction were to take place. If the wages of these men averaged 30s. weekly, the total annual expenditure would be increased by £6,630,000, and this would only form a portion of the extra financial burden which would be placed upon the general body of consumers by the enactment of a statutory eight hours day.

It will be recollected that the Departmental Committee reported that the average week at present worked is a week of 43 hours 13 minutes, which, spread over six days, gives an average of $7\frac{1}{4}$ hours per day, and they suggested that some improvement in the efficiency of labour would take place, especially in certain districts. But can it be seriously expected that men who already work less than eight hours daily would be induced to increase the duration of their labour to this number of hours? British coal miners are already the most industrious of all the coal winners in Europe at the present time. According to the statistical tables issued by the Board of Trade in relation to the production and consumption of coal, the quantity raised per person employed in the United Kingdom fluctuates year by year, but the tendency is not of an upward character. The maximum was apparently reached in 1888, when the average output per miner was 321 tons, and the minimum was in 1893, when the quantity was 247 tons. In 1906 the tonnage was 291 tons, but last year it receded to 284 tons per person employed, both underground and on the surface. If, however, the underground workers only are taken into consideration, it is found that the average production in 1907 amounted to 372 tons, being a decrease of 2 tons as compared with the preceding year. The movement in Germany has also taken a falling curve, the miners producing on an average considerably less than in Great Britain. The French miners individually raise even a smaller tonnage than the Germans, whilst the Belgians occupy a still inferior position to their French colleagues. A period of twenty years in France and Belgium has not materially changed the tonnage output per miner employed, but the German miners have reduced their output by 21 tons in that term, and the British miners by no less than 34 tons since 1887. The miners in Great Britain only work for the purpose of obtaining a certain amount of money within a fixed period, and when they have once earned this particular sum they turn to their sporting and other pursuits for recreation. It is beyond human agency to interfere successfully with these habits, and if those of the men who work less than eight hours a day have their period of labour increased, it is probable they would not work at all on Saturdays, and this would naturally complicate the situation. At any rate, and even with the postponement of the eight-hours' day for a term of five years, it seems hopeless to expect that the useful efforts of the miners would be increased under a statutory limitation of the length of the working day. On the contrary, everything points to a heavy decline in the production, or the introduction of a new army of workers whose wages would have to be provided by the community in general.—*The Engineer*.

DUTCH HERRING FISHERIES.

That fishing has been one of the most important means of Holland's subsistence is natural, the country being bounded on two sides by the North Sea, and containing within itself the Zuider Zee, both waters always having been noted for their abundance of fish. Besides, all the towns surrounding small harbours along the North Sea coast are indebted solely to fisheries for their existence, being cut off by the sand dunes from the fertile soil of the country, and their harbours only capable of accommodating small fishing vessels. In spite of the long established trade in Dutch pickled herrings in the world's markets, the exports thereof to the United States are of comparatively recent date, for it is only within the last twenty years that the exports have assumed any noteworthy proportions, but the United States to-day stands next to Germany as the largest market for Dutch herrings. According to the American Consul at Schiedam, the export of pickled herrings from Holland to the United States for the year ended June 30, 1902, amounted to 131,518 barrels, valued at £153,000, while the export for the year ended June 30, 1907, amounted to 192,000 barrels, valued at £200,000. The herring is caught in the North Sea between Holland, England, Iceland, Norway and Denmark. In the beginning of the fishing season (the first part of June) the

boats go as far north as the sixty-first degree of latitude, in line with the Shetland Islands, where the best quality of herring is caught—the so-called "North-catch." Gradually the herring moves southward, but even in the months of September and October successful fishing is carried on round the fifty-ninth degree. In November and the beginning of December the fishing is carried on along the English coast, near Lowestoft and Yarmouth, and even in the English Channel and along the coast of Holland, but the herring caught here is smaller and not so fat; this is called "South-catch" and "Shore-herring." Lerwick, in the Shetland Islands, has long been used as a landing-place and wharf by the Dutch fishing fleet, and formerly the Dutch fishing firms established regular steamship connection between this place and Holland during the fishing season, in order to bring the herring as quickly as possible on the market. Since 1872, it has for some reason or other been impossible for all the different firms to agree on that point, and only a few of the largest firms are now sending their own steamers there to fetch the first herring catch. The other shipowners let their vessels unload their first catch of herrings at Lerwick in order to have it shipped from there to Holland on stray steamers *viâ* Leith or Harwich, as soon as possible. In old days it was not unusual to secure as much as £6 per barrel for the first herrings arriving in Holland, and even in 1906 from 30s. to £2 10s. per barrel was paid for 1,200 barrels of herrings which reach Holland *viâ* Leith in the middle of June. Shipowners, therefore, endeavour to get the first herrings quickly on the market. The pickling of the herring on all Dutch fishing-boats is done on board, as soon as the herring is on the deck. First, every herring is "gekaakt," which means that a triangular piece is cut out of the neck of the herring with a knife, and the intestines removed. The herring is then packed with salt in barrels, and is ready for shipment as the necessary brine or pickle is forming in the barrel. This method is claimed by the Dutch to be much superior to the methods adopted by other fishermen, who salt the herrings whole on board, and have them cleaned only after they are brought on shore and partly pickled. All Dutch herrings are divided into "North-catch" and "South-catch" or "Shore-herring," and as the North-catch herring is the largest and fattest, it furnishes the best qualities. It is claimed by the exporters that there is in the United States a market for the best qualities only, and that consequently only the best qualities are exported to that country. The two best qualities of herrings are—Prima full milters, and prima full herring. The first sort consists exclusively of the fat male herring, while the second grade consists of both males and females. In the year 1888, the fleet consisted of but 456 vessels, which had increased to 615 in 1898, and had reached the highest number on record in 1903, namely 777, of which 45 were steamboats. In 1907, only 756 vessels took part in the work, owing to the low prices of fish in that year. The number of men engaged in the fisheries have averaged 10,000 during the last five years. As far as can be ascertained, the catch in 1907 amounted to 794,242 barrels, but its value was less than that of 1906, as the average prices of the fish only reached £1 per barrel, while the average price in 1906 was £1 6s. 8d. The reason for the low prices in 1907 was partly ascribed to the rich catch of the English and Scotch fisheries. Besides, the Germans caught a great deal more in 1907 than formerly, which fact had a depressing effect on the Dutch market, as Germany is the largest purchaser of Dutch herrings. It is stated that there were stored in Holland on December 31st, 1907, 142,403 barrels of herrings, against 80,846 barrels on the same date in 1906. The so-called "Bokking" are salted without first being "gekaakt," and smoked after they are brought on shore. This sort of herring is almost exclusively exported to Germany and Belgium. The herrings are disposed of at the so-called "afslag" auction sales, in the different fishing towns. The market price, however, is fixed, according to the price reached at the Vlaardingen "afslag," as the sales held in other places are unimportant compared with those at Vlaardingen. Those sales are not public, inasmuch as it is only the firms and shipowners having "seats" who are allowed to buy and sell. The principals of the large export firms are, as a rule, directors in one or more shipowning concerns, and it is seldom that a man who is a shipowner but not a merchant, appears at the auction sale as seller. Large quantities of herrings are sold outside the "afslag," but the Vlaardinger auction price is in such cases also adhered to. Commissions on sales generally range from one-half to one per cent. Herrings are bought without being seen but with the right of the buyer reserved to examine them later on, and if he finds reason therefore, he can refuse to accept them. The total export of pickled herrings in 1906 amounted to 202,912,457 pounds, of which Germany took about 150 million pounds, the United States 25 million, Belgium 15 million, Sweden 11 million, and Denmark one million pounds, all other countries accounting for less than one million pounds each.

THE WORLD'S FUR TRADE.

The fear has sometimes been expressed that the fur-bearing animals are becoming extinct, but the answer to that is that the fur trade is larger to-day than ever before. It is true that the buffalo no longer comes into consideration as a fur-bearing animal, and the beaver is also nearly extinct in most countries. The sea otter, which formerly furnished 100,000 furs annually, yields hardly 400, and the seal also seems to be rarer as the numbers of sealskins has decreased from 100,000 to 10,000 yearly, but other fur-bearing animals have taken the place of these, and the

dimensions of the American fur trade are at present greater than they have ever been. The American Vice-Consul at Magdeburg says that the depôts in the United States and Canada send the largest part of the furs they receive to the three famous fur markets of the world—London, Leipzig and Nijni-Novgorod. The buying itself is done by expert fur brokers.

In London the furs are sold by auction and an average of £1,000,000 worth of furs, undressed, are disposed of here annually. The principal sale in Nijni-Novgorod takes place in August. There all the Asiatic furs, such as Persian lambs and Astrakans, Mongolian goatskins and Siberian sables, ermine, rare squirrel furs, and, although in very small quantities, otters and seals, are sold. The Leipzig market is held at the great fur "Messe" at Easter time. To it come buyers and sellers from North and South America, Persia, China, Japan, Tibet, and England. The "Messe" lasts two weeks and is an interesting relic of old times, which still retains its importance.

The question has frequently been asked as to why Germany, which furnishes no fur-bearing animals, plays so important a part in the fur trade. This is due to the colouring and dressing. Whole towns and cities are engaged in the preparation of the raw skins. Austria and Russia produce the best squirrel skins for lining, but they must all be sent to Germany to be dressed. The secret of this dressing lies partially in drawing the grease out of the skins without soiling the fur, which is of great importance in the case of ermine, white fox and polar bear furs. Many dressers finish the furs with poor fat instead of butter, or do not properly remove the unpleasant odour as they do not treat the skins with mahogany shavings. Germany takes the foremost place in the colouring of all sheepskins, which is attributed to the composition of the German river water and to the properties of the German clay.

CHINESE RUG MAKING.

Few people are aware of the wealth of China in all sorts of woven cloths, and more especially of the hand-manufactured rugs and carpets, chiefly made in Tientsin and Peking, where one thousand persons or more, according to the American Consul at the former place, are employed in the production of rugs of all kinds of materials, *i.e.*, silk, sheep's wool, camels' wool, jute, hemp, felt, yak hair, and even the hair of the cow. In the production of these rugs and carpets, a high, upright loom is used, consisting of large beams above and below, from which the warp is stretched. In front of these several men and boys—from one to ten, according to the size of the rug—are seated, knotting into the warp tufts from balls of yarn hanging over head, the design in colour being so placed that each workman can see it without difficulty. Workmen are paid at the rate of from five pence to ten pence per day. One square foot is an average day's work. The industry has recently been introduced in several of the industrial schools in China for the employment of the poor. The silk carpets are very like those produced in India, Turkey, or Persia, in colours and quality of material, but vastly different in design if left to Chinese selection. Foreign designs, if furnished, are faithfully copied. These rugs differ greatly in quality. In some the warp is cotton, while in others the warp as well as the nap or woof is silk. Some are made of even surface, while in others the figures are raised. The quality also differs in the number of warp threads used to the inch, which varies from 12 to 20. They are made in all sizes, and are intended for floor, table and piano covers, and wall draperies. The wool rugs are in far greater demand, and are largely used throughout China, Japan, and the East generally. Many are exported to Europe and America. They are made on the same looms and in the same manner as are the silk rugs. Those of all sheep's wool, with cotton warp, vary in price according to the size, design, and colour. The wearing qualities of these carpets make them a very economical floor covering, and age softens and blends the colours, which are, in all reliable places of manufacture, of vegetable dyes. The carpets especially favoured by the local residents and tourists are made from camel's wool. These rugs are heavy, and frequently are fully half-an-inch in thickness. They are fashioned in all kinds of designs—floral, geometrical, and dragon. The rugs made from the other materials mentioned (the yak excepted) are used only by the natives. Those made from the hair of the yak are very rare and expensive, comparing in style and beauty with the finest silk rugs. They are made only in the interior provinces of China. It is interesting to note the origin of the carpet industry in China. The method of manufacture was first used in making saddle-cloths and trappings for horses used in processions, and by Chinese of high rank, developing into the rug and carpet industry on the advent of the foreigner. The saddle blankets are still used, and often are highly finished in the most elaborate designs and patterns.

BRAZILIAN DIAMOND MINING.

With the installation of dredging machinery at points along the Jequitinhonha River, in the State of Minas Geraes, a revolution in the mining industry of the diamond district of Brazil is practically effected, which will probably revolutionise the diamond markets of the world. According to the United States Consul at Rio de Janeiro, American capital has obtained possession of practically all the diamond-bearing territory in the Diamantina country. The success of the work means that a large amount of American money will be spent in Brazilian diamond mining, and it is stated that work on the mines already done has led to such a demand for improved

transportation facilities that an American engineer has been summoned to take charge of the construction of a highway from the end of the railways at Curalinho to the mining country, and American methods of construction are to be followed. The city of Diamantina, which is the centre of the diamond and gold-mining activities for that portion of Brazil, is reached generally by two routes. One is by leaving the railway at Curvello, Minas Geraes, and taking mule train for the three to four days' trip. This route ranges over some very rough country, including two rivers separated by high ridges, the main ridge reaching well towards 5,000 feet elevation where the trail crosses it. It can only be taken by mules or horses. The other route is by leaving the railway at Curalinho, farther north than Curvello. It can be taken in rough stages and wagons, but it is a more difficult journey than by the former route. It is stated that the State Government of Minas Geraes will extend railway connections to Diamantina, provided the Federal Government will not do so, but how soon there will be any improvement is doubtful. The cost of transporting machinery and supplies, under present conditions, is all but prohibitive. The introduction of American rough country wagons on the road from Curalinho to the Jequitinhonha River country, by one of the companies installing dredging machinery there, has been so successful as to attract the attention of the State Government, and that Government at present is making a strong effort to secure the general adoption of these wagons for all such work, by the Brazilian population. There has arisen a demand for American agricultural machinery for the development of the country to meet the requirements for forage and supplies, and the Government is also seeking American capital for the construction and working of a modern meat-packing plant, with a view of furnishing supplies for industrial and agricultural colonies which it proposes to establish in several parts of the State, especially near the diamond mining district. It has been established that some of the diamonds, originally sold as Indian diamonds, came from Brazil. Heretofore, practically all of the output of Brazilian diamonds has gone to Europe, chiefly to Paris and London. The shipments to the United States are increasing in number and value, and it is the expectancy of the American interests now investing so heavily in Brazilian diamond properties that they will be able to sell their products direct to American buyers. It is expected in the Diamantina district that the export tax on diamonds, which has hitherto interfered with the sale and shipment of stones, will be modified or removed altogether, to the advantage of the trade. The exports of diamonds from Brazil in 1906 amounted in value to about £63,000, as compared with £30,000 in 1905, but the figures in neither case were approximate to the actual value of stones exported. These figures also include the declared values of black or amorphous diamonds from Bahia, the trade in which is increasing.

HOME INDUSTRIES.

The Electrical Industry.—It is not surprising that the continued depression of the electrical industry in this country is evoking discussion. The common explanation, namely, that it is to be traced to the Electric Lighting Act of 1882, is not quite convincing. Professor Kapp, who has joined in the discussion, says he has heard this statement often during the last twenty years, but declares that he has never seen it proved. But it is certainly proved that the Act killed the industry until the Act of 1888 came to its rescue. In the year following the passing of the 1882 Act, 106 electric lighting orders were applied for and 69 orders were granted. In the subsequent five years only eight orders were applied for and four were granted. During the period in which legislation had throttled the industry in this country, Germany and America went ahead unchecked, and German and American manufacturers were able, during that time, to raise capital, to gain experience, and to develop their organisation. But that was a quarter of a century ago, and it might be thought that in twenty years during which the electrical industry in the United Kingdom has been in a better position, so far as legislation is concerned, our manufacturers would have recovered lost ground, and even forged ahead as in other industries. But it is not only Parliamentary restriction that has hampered the industry in the past, foreign competition and municipal obstruction have also played their part. It was especially in America that rapid progress was made with electric supply and traction. At one time America was far ahead of Germany as well as of England, but whereas England freely and abundantly imported American electrical plant and apparatus, and has never been able to develop a healthy electrical manufacturing industry herself, Germany foresaw that electrical manufacturing was going to be a great world industry, and determined to foster it, even at some temporary inconvenience, by shutting out American products and giving her own people a chance to gain a firm foothold. This may go far to explain the contrast between the splendidly prosperous electrical German industry and the depressed condition of our own. Mr. Emil Garcke advocates organisation—an electrical league—"in order to discuss commercial and legislative questions affecting the industry. Discussion of our difficulties will suggest solutions, and the League on a proper basis will be able to assist in giving effect to them." He would invite everyone to join the league who is in any way interested in the industry, whether as shareholder, consulting engineer, town councillor, municipal station engineer, manufacturer, contractor, or trader—whether employer or *employé*. The League should be an effective combination of individuals rather than of corporations, companies, or firms. The basis and gathering point of the League would be the desire to advance the general electrical interests of the country, and one of the primary objects should be to provide a common platform for all electrical men,

so as to afford opportunities for the discussion of sectional views. Mr. Garcke says his suggestion is put forward "after close and continual study of all the circumstances, and as the result of much discussion with others." There would seem to be much in it to commend it to those more particularly interested in the electrical industry.

Textile Operatives in America.—The reports sent over to this country from English textile operatives in the silk, woollen, and cotton industries, who have emigrated to the United States and Canada, are not encouraging to others engaged in the same industries who may be thinking of emigrating to those countries. In Philadelphia and other carpet centres there is great depression. English carpet weavers are not accustomed, even in times of depression, to have to reckon with "shutting down" for months together, a common practice in the United States, and weavers who have come back from Philadelphia say they are no better off there at wages ranging from 40s. to 45s. a week than with 25s. a week in certain small English and Scotch carpet towns, where the cost of living is very much less, and where "shutting down" has not to be taken into account. One carpet concern in Philadelphia, established by two Oldham men, has 300 looms, and there are many others of great size which at present cannot find a market for their full output. At Paterson, in New Jersey, where many operatives from Macclesfield are to be found, the silk industry is depressed. Here the state of the English silk industry does not encourage return to the Mother country, where the average yearly earnings of silk weavers at best are too low to content men accustomed to American rates of wages.

Egyptian Cotton Supplies.—The Commission of Enquiry into the deterioration of the Egyptian Cotton Crop has satisfied itself as to the reality of the deterioration of the plant, not only in respect to yield, but also as regards the quality of the fibre. The Commission praises highly the work of the Khedivial Agricultural Society at the Mendelien Experimental Station. Several witnesses before the Commission expressed the opinion that the climate of Egypt has changed radically during the past 10 years with the gradual conquest of the desert by cultivation, but the Commission has found no reason to believe that any appreciable change has occurred. Nevertheless it considers that it will be well to test this conclusion by continuous observation carried out in the cotton-bearing districts that are at some distance from the Alexandria and Cairo observatories. As to fertilisers, the Commission is of the opinion that it is most necessary to increase their use and supply by the import of chemical manures. The Commission suggests that the Government of Egypt should keep full and complete records in the different Provinces of the cotton crop, which would be valuable both to growers, merchants, and foreign manufacturers. A remarkable development of cotton culture is shown in Upper Egypt where the total yield has grown from 399,000 cantars in 1897 to 1,278,000 (estimated) this year. Here, as in the Delta, a constant retrogression in the yield per acre has accompanied the increase in production, namely, from 5·21 cantars per feddan in 1897 to 4·08 in 1908. Taking the same period the decline in the Delta is from 5·59 to 4·42.

Piracy of Trade Marks.—Reference has been made in these Notes to trade mark piracy in China, but it has been difficult to get anything very specific as to this practice in the piece goods trade. The following incident is, however, vouched for by Messrs. Nöel Murray and Co., who have seen and examined the offending goods. They write from Shanghai as follows:—"Our attention has been drawn to a very glaring case of piracy of trade marks, the property of a British firm which were registered in England, one in January, 1888, and the other in December, 1892, and regularly used here on fine white shirtings imported from Manchester. It is now discovered that a much inferior quality of white shirting is imported from Japan bearing precisely the same Chops, and even the characters for the foreign long name, which is adding insult to injury. It is to be hoped that the new convention respecting trade marks in China, said to have been practically concluded between Great Britain and Japan, will soon put a stop to that sort of thing. There is no question as to the exact reproduction of the Chops, for we have photographs and the two cloths bearing them before us."

Nickel Steel.—A considerable development is taking place in the Sheffield steel trade by the manufacture on a large scale of nickel steel motor axles. It is found that nickel steel, that is steel with a mixture of 3 per cent. of nickel, is a very satisfactory material for the axles of motor-cars, and a Sheffield firm is devoting itself to this speciality with much encouragement from motor makers. It is understood that the attention of the Admiralty has been directed to the advantages which this nickel steel possesses in big gun making, and that the firm in question has been able to supply such satisfactory proofs of its ability to produce ingots of nickel steel adapted to the making of guns of all calibres that it has received a large Admiralty order.

Whitewashing Roofs.—The output of a cotton mill is appreciably affected by the comfort of the operatives, and in this tropical weather comparative coolness means much. The *Manchester Guardian* says that several cotton manufacturers and spinners have recognised this, and are keeping their mills cool by the simple and inexpensive plan of whitewashing the roofs. It is surprising that this practice is not more generally adopted, not only for cotton mills, but for buildings of all kinds. No doubt the roofs are unpleasant to the eye when under the hot sun, but one does not see much of them unless it be from a

considerable distance, in which case the glare loses much of its painfulness. As a rule the roofs only require whitewashing once a year, at the beginning of the summer. Perhaps it is too much to expect whitened walls, but in large, smoky towns, with tall buildings and narrow streets, whitewashed walls would add greatly to the brightness, cleanliness, and coolness of many a purlieu.

Manchester and Turbines.—The Manchester Corporation Electricity Committee have decided to instal a 6,000 kilowat Zoelly turbine in the Stuart Street Power House. This turbine will be the largest of the Zoelly type in Great Britain, if not in the world. Hitherto the fight has lain between the Parsons and the Curtis types of turbines, and the adoption of the Zoelly type will be watched with interest by engineers to see if the result justifies the change. The makers are Messrs. Howden and Co., Ltd., who have not been competitors in the turbine field very long, but they have successfully built one smaller turbine for the Powell Duffryn Colliery in South Wales. The chief advantages claimed for the Zoelly turbine are reliability and freedom from blade stripping. It was originally made by Escher Weiss and Co., of Zurich, and is now being made by Messrs. Howden, Mather and Platt, and John Musgrave and Son.

GENERAL NOTES.

Opium in China.—The recent anti-opium legislation in China, and the supposed general agitation against the use of the drug, has not as yet been followed by anything like a general decrease in the amount of opium imported into the country. On the contrary, the actual import of foreign opium in 1907, so far as Amoy is concerned, exceeds that of any year since 1898. The chief demand was for Bengal opium, the rates for which figure from 800 to 900 dollars per chest, and these, according to Mr. Consul O'Brien-Butler (No 4014, Annual Series), are steadily rising owing to the action of the Indian Government.

Wages and Living in Dresden.—The Statistical office of the City of Dresden has recently published a report on the advance of the cost of living of a working man's family in the period from 1903-6, and has arrived at the following general results. The maximum increase by £3 15s. od. or 4 per cent., the minimum £1 or 1·9 per cent., average £2 6s. od. or 3·1 per cent. Of this increase meat alone accounts for, taking the average, 1·2 per cent. But wages have also risen in proportion to more than cover the increased cost of living. In other words the Saxon working man enjoys greater actual prosperity than he did five years ago. It may be noted that in Saxony, as elsewhere in Germany, the population of the towns continue to increase at the expense of the country. Referring to this point, Consul-General Baron Bernhard von Tauchnitz (No. 4008, Annual Series) says that in 1895, something like 13·8 per cent. of the population was still devoted to agricultural and forest pursuits, but in 1907 the proportion had fallen to a little over 10 per cent.

Sulphur in Fruit Curing.—Reporting on the trade and commerce of California, Mr. Consul-General Hearn (Annual Series 3998) says that the most important question before fruit growers, packers, and buyers of cured fruits to-day is the use of sulphur in curing. The general attitude of the pure food authorities at Washington is opposed to the use of sulphur in the preparation of any food product. During the past season a ruling against sulphur in this direction was issued, permitting a very small quantity only to be used. The bulk of the fruit crop was ripening and being dried at the time, and growers and packers were perplexed for a few weeks as to what steps to take. After forcible representations had been made to those in authority, it was announced that no attempt would be made to enforce the provisions of the decision promulgated, except in the case of frequent violations in evident bad faith, and under this assurance matters progressed for the season. Next season, says Consul-General Hearn, the question will be threshed out on its merits, and a definitive decision arrived at which is concurred in and understood by all concerned.

The Parcel Post in Persia.—In his report on the trade of Khorasan, the Consul-General, Major P. Molesworth Sykes, says (No. 4006, Annual Series) he has been trying to ascertain by practical experience whether it would not pay to make use of the parcel post more extensively than at present, and his inquiries all tend to show that, for suitable articles, it should form a valuable adjunct to the caravan routes, which are gradually being ousted by more modern methods of transport. From the United Kingdom, Meshed is reached by Askabad, and parcels up to 11 lbs. are carried for 3s. 6d. as far as the Persian frontier. Thence to Meshed, the Persian authorities charge, on the 11 lbs., at the rate of 2¼d. per lb., so that the cost, from Europe, works out at about 6¼d. per lb. The average time occupied is about five weeks, and, needless to say, this compares more than favourably with the six to nine months occupied by goods on the long round journey. A second point is that there is little fear of articles being spoilt by damp, whereas no tin linings can prevent damage to goods which are exposed to the weather for many months at a time, apart from the rough handling incident to camel or mule transport, which works open the tin linings, and breaks up the goods. Persian shopkeepers are beginning to utilise this route, which is particularly suitable for watches, &c., and if only there were suitable agents, the Consul-General thinks much might be done.

Journal of the Royal Society of Arts

No. 2,904. VOL. LVI.

FRIDAY, JULY 17, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

EXAMINATIONS, 1909.

Next year's Examinations will commence on Monday, March 29. The last day for receiving entries will be February 23.

The examinations are now arranged under the following stages :—Stage I.—Elementary; Stage II. — Intermediate; Stage III.—Advanced.

The subjects include : — Book - keeping, Accounting and Banking, Shorthand, Type-writing, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Handwriting, and Modern Languages.

In the Advanced and Intermediate Stages First and Second-class Certificates are granted in each subject.

In the Elementary Stage Certificates are given in each of the subjects enumerated. These are of one class only.

In Rudiments of Music Higher and Elementary Certificates are given; in Harmony Higher, Intermediate, and Elementary Certificates.

The following is the Time Table for 1909:—

	Monday, March 29. (7—10 p.m.)	Tuesday, March 30. (7—10 p.m.)	Wednesday, March 31. (7—10 p.m.)	Thursday, April 1. (7—10 p.m.)	Friday, April 2. (7—10 p.m.)
Advanced Stage.	Book-keeping. Précis-writing. Economics. Danish and Norwegian.	Arithmetic. Commercial Law. German. Italian. Spanish.	French. Commercial History and Geography. Typewriting (7.30 to 10 p.m.).	Accounting and Banking. Shorthand (140 and 120 words per minute) (7.15 to 10 p.m.).	Portuguese. English. Russian. Swedish. Chinese. Japanese. Hindustani.
Intermediate Stage.	Typewriting (7.30 to 10 p.m.). French. Danish and Norwegian. Commercial History and Geography.	Book-keeping. Précis-writing.	English. Economics. Spanish.	Arithmetic. German. Portuguese. Italian. Russian. Chinese. Japanese. Hindustani.	Swedish. Shorthand (100 and 80 words per minute) (7.15 to 10 p.m.).
Elementary Stage.	Handwriting and Correspondence. French.	German. Italian. Typewriting (7.30 to 10 p.m.).	Book-keeping Spanish.	Shorthand (50 words per minute (7.15 to 10 p.m.).	Commercial Geography. Arithmetic.
Music.		Harmony.	Rudiments of Music (7 to 9 p.m.).		

A fee of 2s. 6d. is required by the Society from each Candidate in each subject in the Advanced and Intermediate Stages, and in the Elementary Stage a fee of 2s. for one subject, and 1s. for each additional subject taken up by the same candidate. The fees for Harmony and Rudiments of Music are the same as for Stages II. and III.

The special subject for Commercial History and Geography for 1909 will be "South and Central America."

Examinations are also held in the Practice of Music, and Vivâ Voce Examinations in French, German, Spanish, Portuguese, and Italian.

The programme for 1909 will be issued about the beginning of September.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

FUEL AND ITS FUTURE.

By Professor Vivian B. Lewes.

Lecture I.—Delivered March 9, 1908.

Coal, the earth's great store of heat energy —energy which buried latent for long ages is liberated again as sensible heat by the processes of combustion, which cause the reversion of the fuel once more into the compounds from which it sprang—is a heritage of which the world only realised the importance a little more than a century ago. Yet it was the distribution of that heritage that governed the fate of nations, that made great empires and relegated other countries to more or less obscurity. A thousand years ago it was the force of arms, of civilisation, of arts, that made a nation great: to-day it is the force of fuel, which by developing commerce governs the distribution of power on the face of the globe.

A century has passed, and Great Britain occupies a position that is a pride to her sons the wide world over, but in our elation we are too apt to overlook the fact that Nature has had quite as much to do with our supremacy as our own endeavours. In this course of lectures I desire to discuss our methods of employing the great natural advantages we have enjoyed, and how far it is in our power, by using our fuel supplies to the best advantage, to ward off that fatal day when, dependent on other nations for our sources of energy, we must of necessity lose our pride of place.

The fuel question is one of the most interesting and important problems of the present day, not only because our methods of generating power from fuel are undergoing changes of the most radical character, but also because it is being slowly borne in upon us that we must have some thought for the future, and that the prodigal waste that has characterised our consumption of fuel in the past, and the fatal effect it is having upon our atmosphere and lives, must in the interests of future generations give way to more carefully considered methods of working.

More than twenty centuries before the nature of combustion was understood, and the causes which led to the generation of heat by its aid were realised, it had been recognised that the burning of wood and dried vegetable matter could be utilised to eke out the warmth derived from the sun, whilst it was not until the thirteenth century that the employment of bituminous coal as a fuel was first attempted, its use being forbidden in 1306 owing to the horror created by the pollution of the atmosphere by its smoke. The gradually increasing shortage of wood and charcoal however, the limited employment of peat, and the necessity for a more abundant fuel again brought the use of coal to the front, but the reign of Queen Elizabeth saw it still under a ban for the same reasons as before. There was nothing else to use, and as the country was becoming rapidly denuded of timber, coal at last established itself, in spite of frequent protests, as our principal domestic fuel.

The use of coal for the generation of power was of even more recent date, and the past century will always be celebrated in history as being the period during which the energy locked up in our coal deposits was first utilised for the advancement of our manufacturing processes, and in which the supremacy of nations was largely determined by the possession of coalfields.

It must be remembered that it was only in 1781 that the translation of heat energy into mechanical work was first satisfactorily solved by the invention by James Watt of the steam engine, whilst last year we were celebrating the centenary of the first steamboat, and it was not until 1829 that Stephenson gave the world the locomotive.

The discovery by Lavoisier of the part played by the oxygen of the air in combustion, and his enunciation of the great truth that the heat evolved during the burning of a substance is due to the rapid evolution of energy during chemical combination, mark the last years of the eighteenth century as being the starting point of our ideas on the true nature of this phenomenon.

The great generalisations which underlie all processes of change, and which we know as the conservation of energy and of matter, teach us that no such powers as creation or destruction are vouchsafed to us, and that although we may change the form of matter to an almost endless extent, and translate one form of energy into any other, our powers are limited to these transmutations, and can go no further.

When we attempt to define the sources of energy available for the generation of power, we see we are limited to gravity, muscular

force, and heat, and when in turn we seek the sources that give rise to these, we find the sun behind them all, and without sun all would cease. The great factors in the storing of the sun's energy in such a form that it can be reproduced at will, are those marvellous changes which take place during the growth of vegetation, and which over countless ages built up for us the accumulations of fuel which the past century has seen squandered with such a prodigal hand.

In the whole of Nature's wonder-book there is nothing that appeals more to our sense of the marvellous than the way in which all the waste of animal and vegetable life is converted by decay into those simple compounds, carbon dioxide and water vapour, which are again used in the wonderful processes by which all forms of life are synthetically recreated.

It is the sun's rays which are the mainspring of this regeneration, and the growth of vegetation is the means by which it is brought about. All the ordinary forms of plant in which the green pigment, known as "chlorophyll" is present, owe their growth to energy derived from the sun, under which the chlorophyll contained in the small glands of the plant absorbs carbon dioxide and water vapour from the atmosphere, whilst more moisture and traces of mineral salts are drawn in by the roots. Once absorbed the carbon dioxide and water vapour under the influence of the chlorophyll commence a marvellous series of changes, which result in the formation of the first visible product, the starch granules and also sugars, which afterwards become practically the food of the plant, and are incorporated as the cellulose or woody fibre of which the solid portion chiefly consists, the completed reaction being of some such nature as that expressed by the equation—

$$\left.\begin{array}{ccc}\text{Carbon dioxide} & & \text{Water vapour} \\ 6\,CO_2 & + & 5\,H_2O\end{array}\right\} + \text{Sun's energy} = \left\{\begin{array}{ccc}\text{Cellulose} & & \text{Oxygen} \\ C_6H_{10}O_5 & + & 6\,O_2\end{array}\right.$$

And it is this oxygen so liberated in the early days of the world's creation which according to some theorists formed the atmosphere, and has since kept the oxygen present in it a practically constant quantity.

It must be borne in mind, however, that, although such an equation is capable of representing the sum of the actions taking place, yet it only in reality represents the first and final stages of a series of most wonderful and beautiful reactions, the exact course of which is but little understood. The fact that the sun's energy is necessary to bring about this reaction is made manifest by the growth of vegetation when kept from the light, when it merely gives rise to a few sickly and colourless shoots formed by the plant food already stored in the plant or seed, whilst on the other hand recent experiments have shown that ordinary vegetation can be accelerated in its growth by the illumination from certain forms of artificial light during the hours of darkness.

Probably the first attempt to use artificial light for hastening the growth of plants was made in 1861 by M. Hervé-Magnon, whilst 20 years later Siemens, by experimenting with an arc lamp of 1,400 candle power, placed 10 feet from the plants, with a glass screen interposed, came to the conclusion that this illumination was capable of producing an effect equal to about half that of the sun. In more recent years various artificial lights have been employed for accelerating growth, and it has been found that nearly all plants, aided in their development by artificial light to which they are exposed during the usual hours of darkness, reached the flower and fruit bearing stage much earlier than with sunlight alone, some few, however, like the onion, declining to be hurried. That this growth and progress is not at the expense of root formation is abundantly proved in the case of such plants as radishes, in which not only was the top growth three times that of a similar plant grown in sunlight alone, but the root growth also amounted to 2½ times the normal in a given time.

From the exhaustive researches which have been made upon plant life, it seems fairly clear that the function of the chlorophyll in the growing plant is practically three-fold. It has been shown that it is those rays in the immediate neighbourhood of the red and orange in the spectrum which most keenly excite the assimilation of carbon dioxide and water vapour, and that the chlorophyll absorbs those rays which hinder the formation of carbo-hydrates, transforming rays of short wave-lengths into those rays which most favourably effect the production of the sugars and starch, which are the food of the plant structure, and that it also acts by the conversion of light into heat.

The usual statement that the solid matter of the plant consists of cellulose is, of course, only an approximation to the truth, as cellulose is only one of several modifications produced

by the actions taking place in the growth of the plant, but as from a calorific point of view the other organic bodies present have practically the same thermal value, it is a convenient simplification to take wood as being composed of cellulose, water, and the constituents of the sap, mineral salts and extractive matters, which may be resinous—as in coniferous woods, extractive—as in beech or birch, or tannin—as in oak.

The chemical actions which have resulted in the formation of the cellulose have required an expenditure of energy which, in the primary decomposition of the carbon dioxide and water vapour, can be expressed in terms of the heat necessary to raise a unit weight of water one degree.

A unit weight of carbon in burning to carbon dioxide raises 8,137 units of water 1° C., or 14,647 units of water 1° F. The former we speak of as "calories" and the latter as "British thermal units."

In the same way a unit weight of hydrogen in burning to form water develops 34,500 calories, or 62,100 British thermal units, and in order again to decompose the carbon dioxide and water so as to liberate the unit weight of carbon and of hydrogen, just as much energy expressed in heat units will be absorbed. As in the growth of the plant this energy has been derived from the sun, and has been partially rendered latent in the cellulose, when we burn that compound in the form of wood so as again to convert the carbon and hydrogen to carbon dioxide and water vapour, we once more set free the stored energy in the form of heat and can render it available for heating purposes.

The variations in the physical properties of wood are dependent upon the constituents of the sap and the density with which the solid matter is packed away in the structure, and when the wood comes to be burnt its calorific value is found to vary slightly owing to these factors, and also to the amount of moisture which it contains; as upon the constituents of the sap will largely depend the amount of ash which is formed, and upon the moisture the amount of heat which will be rendered latent in the conversion of the water into steam. Moreover, in the formation of the cellulose oxygen equivalent in quantity to that which was originally in combination with the hydrogen will have been again taken into combination in the formation of the plant's structure, with the result that air-dried wood, when tested for its calorific value, is but a poor fuel. The figures obtained with various kinds of wood, when tested in the Mahler Bomb, are shown in the following Table.—

Calorific Value of Wood.

	Calories.	British Thermal Units.
Ash	4,771	8,480
Beech	4,774	8,591
Birch	4,771	8,586
Elm	4,728	8,510
Fir	5,035	9,063
Oak	4,620	8,316
Pine	5,085	9,153

The moisture present in a sample of wood will vary enormously with the time of year at which the tree has been cut down, and also with the nature of the tree, so that whilst as little as 18 per cent. of moisture has been found in one kind of wood, it may exceed 50 per cent. in another, whilst, under the most favourable conditions, air-drying will only reduce the moisture in wood to from 18 to 20 per cent. It may, therefore, be roughly stated that at the best, wood will only contain 80 per cent. of combustible matter, whilst the large amount of heat absorbed in heating and evaporating the water present is a serious drawback to it as a fuel.

The combined oxygen also present in the cellulose, as has been before indicated, seriously detracts from its value, and where wood is the only fuel that can be employed, and great local heat is required, a fuel of practically double the value of wood can be obtained by its conversion into charcoal before use. Under the influence of destructive distillation the contained moisture and combined oxygen are driven forth as water vapour, and although four-fifths of the weight of the wood is lost in the liquid and gaseous products escaping, yet the 20 per cent. of carbon that remains on burning is free from the drawback of having the intensity of the heat of combustion lowered by the rendering latent of heat, which, in the case of wood, was lost in vaporising the water and bringing about the decomposition.

In the same way that human beings and animals of the present day are of a very different and higher type to those which first appeared on the earth's surface, so our plant life has undergone a great alteration in character, and as we trace by the light of geology the birth and growth of vegetation, we are led to the conclusion that as the earth cooled down, soil was first formed upon its rocky surface by the disintegrating action of

water containing carbon dioxide and by those processes to which we usually give the name of "weathering." Spores of the lower forms of plants, like lichens and mosses, then appeared, and in their growth fixed the carbon and hydrogen from the carbon dioxide and water vapour to the atmosphere. By their decomposition they supplied the soil, which up to that time had been of a purely mineral character, with the organic constituents necessary for the growth of vegetation of a higher order.

This next form of vegetation, urged on in its growth by the heat permeating from the cooling mass of the earth, and fed by the excess of carbon dioxide and moisture in the air and the virgin soil in which it grew, attained a rapidity and luxuriance of growth which probably has never been equalled. In type it consisted chiefly of cryptogamic plants, such as club mosses, sedges, and other forms of marsh vegetation, which however, instead of growing to a height of a few inches, attained enormous dimensions. Dying down year by year they formed a densely packed mass of vegetable matter, which undergoing the processes of checked decomposition of the same character as can be recognised in the peat deposits of the present day, gradually built up those masses of semi-decomposed vegetable matter which were afterwards converted by time, heat, and pressure into the coal seams.

The formation of peat is apparently due partly to fermentation when exposed in its wet state to air, and partly to checked decay when covered with water, and it is the latter process which is the most valuable in converting it into a form which is available for fuel.

When decomposing matter is freely exposed to moist air, processes of fermentation and still further oxidation convert it ultimately into carbon dioxide and water vapour, leaving as a residue only the mineral matters and more resistant hydrocarbons, the latter in turn also disappearing, and it is by such processes of decay that Nature cleanses the surface of the earth from all waste vegetable matter. When, however, the dead vegetation has its decay checked by immersion in water or the deposition over it of silt or soil of such a character as to cut off from it the supply of atmospheric oxygen, the processes of decay continue, but instead of exterior oxygen acting on the decomposing molecules, the changes that take place are restricted to those set up between the constituents of the molecule itself, and result in the elimination of carbon dioxide, water, and methane, with consequent lowering of the proportion of hydrogen and oxygen left in the residue.

Enormous areas of peat exist at the present day not only in the British Isles, but in even greater quantities in Russia, Sweden, Norway, Germany, and Finland, whilst in Canada and America the peat bogs are still more vast, and in the future this material will probably play an important part in the supply of fuel when the depletion of our coal supplies drives us to utilise these natural stores.

The great interest, however, attaching to peat at the present moment is that the same action which converts cellulose into peat will, if continued under conditions of considerable pressure and higher temperatures than ordinarily exist at the present day, convert the peat deposits into a coal seam.

Taking the luxuriant vegetation of the carboniferous era, it is easy to imagine the way in which the huge peat bogs were formed in the low-lying watersheds, and in which the agglomeration of vegetable matter swept down by the hurrying streams accumulated in the deltas of the prehistoric rivers, whilst the volcanic actions which marked this period would often cause so great an alteration in the earth level, that the decomposing vegetable matter became subject to the inrush of water bearing with it huge quantities of mud and silt, which, depositing above the collected vegetation, gradually hardened there and formed the strata which we find above the coal.

Nor were these actions confined to that particular period to which we look back as the carboniferous age. We find that whenever the conditions were favourable for the deposition of great beds of vegetable matter, actions of a similar nature have led to its conversion into coal in strata of a more modern character, and the formation of coal appears to have been going on ever since the inception of vegetable life on the earth's surface, and there is no reason to doubt that the swamps and bogs of the sub-tropical forests of the present day are to a minor extent, carrying on the early stages of the same action.

The chemical actions that took place during the period when the peat deposits, heated from below by the earth's temperature and pressed on by the superincumbent deposits above them, underwent those changes in composition which we now recognise in our coal, can be traced by analysis, and the

following Table indicates the way in which the gradual elimination of the hydrogen and oxygen altered the cellulose of the growing plant to the product of our coal seams.

THE CONVERSION OF WOODEN FIBRE TO COAL (Butterfield).

	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Sulphur.	Ash.
Cellulose	44·4	6·2	49·4	—	—	—
Dry wood (average)	48·5	6·0	43·5	0·5	—	1·5
Dry peat	58·0	6·3	30·8	0·9	trace	4·0
Lignite	67·0	5·1	19·5	1·1	1·0	6·3
Coal	77·0	5·0	7·0	1·5	1·5	8·0
Anthracite	90·0	2·5	0·25	0·5	0·5	4·0

This action is made even more manifest by calculating the analyses so that the carbon is kept as a fixed quantity, which brings into bold relief the gradual elimination of the other constituents of the cellulose.

THE CONVERSION OF WOODY FIBRE TO COAL. (Percy).

	Carbon.	Hydrogen.	Oxygen.
Wood	100	12·18	88·07
Peat	100	9·85	55·67
Lignite	100	8·37	42·42
Bituminous coal	100	6·12	21·23
Anthracite (Wales)	100	4·75	5·28
Anthracite (Pennsylvania)	100	2·84	1·74
Graphite	100	0·00	0·00

These changes in composition may also be traced in the calorific value, and show the thermal advantages gained by the elimination of the oxygen during these processes of natural distillation.

	Calories.	British Thermal Units.
Wood	4,771	8,588
Peat (dry)	5,600	10,080
Lignite	7,000	12,600
Bituminous coal	8,446	15,203
Anthracite	8,677	15,618

It is not, however, time alone which causes alteration in the character of coal, the factors of temperature and pressure also play so important a part in its composition that it is unsafe to base any far-reaching ideas as to the age of a coal from the amount of natural carbonisation which it has undergone. One may look upon coal as consisting of a basis of carbon together with the mineral matters that were mostly present in the sap of the plant, and on the combustion of the coal will remain behind as ash, these forming the solid residue which is left on heating the coal out of contact with air. The portion which under these conditions escapes, and may therefore be termed the volatile matter, consists of various compounds of carbon and hydrogen and other more complex bodies containing not only these elements but also the oxygen and nitrogen present in the coal.

The proportion of volatile matter present, consisting as it does largely of hydrocarbons, makes a wonderful difference to the way in which a coal burns, the presence of hydrogen and lower members of the hydrocarbon series giving the coal ease of ignition and the property of burning with flame, whilst the more complex hydrocarbons and organic bodies render the flame so produced heavy and smoky in its character. If a coal which contains a very small percentage of volatile matter, such as anthracite, be taken, it is found difficult to ignite and almost impossible to burn without specially arranged conditions of draught, whilst the more bituminous coals, such as cannel, can be ignited by the flame of a match, and will burn with the greatest ease.

With the increase in bituminous matter in the coal, the fixed carbon or coke left on distillation naturally decreases in quantity, and coals are generally classified on the basis of the amount of fixed carbon they contain into lignites, cannels, bituminous coal, steam coal or semi-bituminous coal, and anthracite, the percentage of carbon varying from 65 per cent. in some lignites up to over 90 per cent. in the anthracites. The relation existing between the composition of the coal and its powers of smoke production is one that will have to be discussed again in considering the fitness of fuels for the class of work they have to perform.

Any form of bituminous coal when subjected to a raised temperature begins to yield products of a liquid and gaseous character, and if the temperature be kept at the lowest point at which any action can take place, the liquid distillates formed are of an oily character and not greatly dissimilar to some crude mineral oils. Indeed, it seems highly probable that when the coal has been formed under conditions where no escape of gaseous matter could take place owing to the impermeability of the low-lying strata, a natural distillation at very low temperature has gone on over long ages, and some of the bituminous products of the decomposition distilling into the earthy strata next to the coal has formed with it the shales, which differ from coal in that the fixed residue left on their distillation

consists of earthy matter instead of coke. It is also perfectly well known that in some of the more extensive peat bogs a trickle of oil is occasionally found escaping from the decomposing mass, showing that even in the early stages of the action, oils are produced, whilst it was from a spring of oil in the shale measures of the Alfreton Colliery that Young first got the idea of utilising shale for distillation as a source of mineral oil.

It has been known for centuries that in certain districts of America and Eastern Europe, a scum of oil would frequently gather on the surface of the pools and streams, and these districts have since become famous as the great sources of American and Russian oil supply. Although many observers cling to the belief that the oil fields have been formed by animal or mineral agency, there seems but little reason to doubt that our liquid fuels, like the solid, are of vegetable origin, and are indeed by-products of great subterranean distillations, in which at high pressures and comparatively low temperatures the accumulated vegetation of past ages has been partly liquefied or even gasified, as the same areas which yield our stores of mineral oil are also famed for the production of natural gas.

The Pennsylvanian oil fields of America yield crude oil consisting largely of members of that group of hydrocarbons which we know as the "saturated series," the lower and more simple members of which are gases, and with the fifth member commence to give highly volatile liquids yielding the pentane which we use for our standard of light, and the hexane and heptane dear to the motorist under the name of "petrol," whilst higher member of the series constitute the burning, lubricating, and fuel oils which have played so important a part in the technical world during the past fifty years.

The Russian oils, on the other hand, contain hydrocarbons of a slightly different character, having as chief constituents "naphthenes," a group which, although in many properties similar to the saturated hydro-carbons, yet in composition must be ranked with the unsaturated. So laborious, however, is the separation of the hydrocarbons present in these great natural distillates, that our knowledge of their constituents is still far from perfect, and recent researches upon the tars obtained at low temperatures from coal show that they are characterised also by the presence of the naphthene group.

The valleys of the Alleghany, which gave so abundant a supply of oil to Drake and the pioneers of the oil industry in the early sixties, also yielded that great output of natural gas which concentrated the manufacturing activity of America to so large an extent in these districts. Although such gas is found in small quantities in many parts of the world, no output of the same magnitude has ever been discovered.

This gas, which is by far the most valuable of the gaseous fuels, is practically methane, its character being indicated by the following analysis:—

Composition of Natural Gas.

	Russian (Baku).	American (Ohio).	English (Heathfield).
Hydrogen	0·98	1·89	0·00
Methane	93·09	92·84	93·16
Ethane	3·26	0·35	2·94
Carbon dioxide	3·18	0·75	0·00
Nitrogen	0·49	3·82	2·90
Oxygen	0·00	0·35	0·00
Carbon monoxide	0·00	0·00	1·00

Weight for weight natural gas is the most valuable of all the fuels, having a calorific value of 12,008 calories (21,615 British thermal units), and its history affords a graphic object-lesson of what within a hundred years will be our condition with regard to coal supply, the actions, however, having been concentrated into a period of not less than 50 years.

With the first discovery of natural gas waste of the grossest character took place, followed by a period in which, the value of the gas having been realised, it was consumed with the utmost prodigality, and no thought was ever given to the future. Then as reduced pressures in the supply began to give a warning note, economy at length began to be exercised, whilst now the rapidly decreasing supply threatens failure at an early period and has at length forced attention to every point at which economy can be obtained.

MAHOGANY.

Mr. Frank Tiffany being unfamiliar with the infinity of pitfalls presented by the scientific synonyms and trade names of economic plants, I would wish to supplement his most interesting paper on the sources and the botanical and commercial nomenclatures of Mahogany by a statement of them in the systematic and detailed form required for its precise and complete intelligibility.

The word mahogany is the English rendering of, as is generally accepted, the native West Indian

name of the stately forest tree indigenous to Mexico and Isthmian America, known to botanists as the *Swietenia Mahogani* of Linnæus. Its bark is a febrifuge; its red wood has in less than three hundred years come into general European use for furniture making; and its seed reduced to powder is the basis of an unctuous cosmetic famous throughout the tropical Americas from the date of the Incas, 10th to 16th century A.D. Sir Walter Raleigh used its wood in repairing his ships at Trinidad in 1597. The tree itself was first observed by European botanists in its native forests by Mark Catesby, in 1710-19, and by Baron Nicol Jacquin about 1763—the date of the publication of his "Selectarum Stirpium Americanarum Historia." The wood became an article of commerce with England in 1724; and sometime in the earlier decades of the Victorian era, the Messrs. Broadwood, the celebrated pianoforte makers, were recorded to have paid £3,000 for three logs of mahogany cut from a single tree. "Spanish Mahogany" is the produce of Cuba and Hayti, and was plentiful also in Jamaica, until the island came under the economic mismanagement of England. "Campeachy Wood," and "Honduras Mahogany," called also "Baywood," are the produce of the mainland, and the chief denominations of the timber now imported into the United Kingdom. It would be easy to restore the mahogany forests of Jamaica. The tree also grows well in Burmah, and I had no difficulty with it in Bombay, where I introduced it into many gardens; and "a cutting" I planted before my bungalow in Victoria Gardens, is now one of the noblest trees on the island, and is popularly named after me, *Balbood-ki-jar.*

The *Swietenia Mahogani* belongs to the Natural Order Meliaceæ, or Cedrelaceæ, to which all the Indian substitutes for mahogany also belong. These are:—

1. *Azadirachta indica*, Ant: Juss:, *Melia Azadirachta*, Linn:; a forest tree, of stately proportions, and noble evergreen foliage; with a bitter bark ["Margosæ Cortex"], and a hard, red, heart-wood: the Sanskrit *nimba*, *i.e.*, "the strength-giver," or "health-giver;" the Persian *azadirakht-i-Hindi*, *i e.*, "Indian-azadirakhta;" the Hindustani *nimb*, the Mahratti *nim*, *lim*, and *vim* [compare Bhima, the name of the second of the five heroical Pandavas in the "Mahabharata"]; and the *Arya- vepu*; and *Arya-vepon*, *i.e.*, literally, the "Aryan-tree" of the peoples of the Malabar Coast. It is, through the Portuguese, the Margosa Tree [see No. 2] of Europeans.

2. *Melia Azedarach*, Linn: a deciduous Persian tree, naturalised in India; the Persian *azadirachta*, *i.e.*, "free [speech] tree," or "Parliament Tree," or "Tree of Liberty; the Canarese and Telegu, *Turakavepa*, *i.e.*, literally, "Turkish Tree," but here meaning "Muslim - tree;" the Hindustani *mahanimb*, or "great nimb;" and known to Europeans as the Persian Lilac [the "Lilacs" of English gardens being themselves, as in name also, of Persian origin], the Margosa Tree [see No. 1], the Bastard Mahogany, the Bastard Cedar, and the Pride of China. It was under some such notable tree that the prehistoric Aryas, wherever they settled down in Asia and Europe held their tribal councils;—according to tradition discussing under its shade every burning question that arose among them; first when drunk, and again when sober: and this primæval practice of theirs is possibly the ultimate origin of our own two Houses of Parliament, the House of Commons representing the nation drunk, and the House of Lords the nation sobered!

3. *Soymida febrifuga*, Adr: Juss: *Swietenia febrifuga*, Roxburgh; a forest tree of Western and Central India; with a bitter bark ["Cortex Swieteniæ"], and a bright red, hard, and durable wood; the Hindustani *rohan*, *i.e.*, "red [-tree]"; the Telegu *somida*, *i.e.*, "the divine"; the Canarese *swamimara*, *i.e.*, "divine tree"; the Hindustani *rohitaki*, *i.e.*, "red wood"; and Tamil *shemmarum* [corrupted by force of its brightly-coloured wood from *swam-marum*] *i.e.*, "red tree": the root of all these Southern Indian names for this tree being the Sanskrit *sva*, [compare Latin *suus*, French *soi même*], which appears in such Indian words as *swayambhava*, "the self-existing," *i.e.*, Almighty God, and also Nature; *swami*, an "idol," or ideograph of Deity; *swastika*, the symbol [when revolving by the right] of the sun, life, health, glory, &c., and [when left handed] of the moon, death, misfortune, disgrace, &c.; *swadesha*, *i.e.*, "one's own country"; and *swaraj*, actually the share of revenue claimed by the paramount power of its tributary states, as the Mahratta *chouth*, but which to-day in the minds of the Orpheustical Bengalis, has come to signify Home Rule. Its English names are Bastard Cedar, Red Cedar, Coromandel Red Wood, East Indian Red Wood, Indian Red Wood, and Rohan Tree.

4. *Chukrasia tabularis*, Adr: Juss; *Swietenia Chickrasa*, Roxburgh; a magnificent, deciduous forest tree of Western India, Eastern Bengal, and Burmah; with flowers used for dyeing red and yellow; an astringent medicinal bark; and a helvous heart wood, close grained, beautifully veined, lustrous as Satin Wood, and greatly prized by cabinet makers. Extensively used in the construction and decoration of the palaces of the Kandyan kings of Ceylon, it has remained for centuries unaffected by the exacting heat and dampness of that terramarine tropical climate. It is the Hindustani *chukrasi*, and the Tamil *aglay-marum* [which gives its name to the congeneric *Aglaia odoratissima*], and *Mathagari-vembu*, *i.e.*, "Mathagary-Neem"; and the Telegu *Chittigangu-chettu*, that is "Chittagong-wood-tree," and *magani-maram*, literally, "in moisture (growing) tree," a term which may be derived, with a twist of form to give it a topical meaning, from the hypothetical Caribbean name, as rendered by European lips, of *Swietenia Mahogani*; or the etymological source of the otherwise unmeaning designation given

to (Honduras) "Baywood" on its first introduction into Europe. I am unable to determine the question, but incline to the conjecture that "mahogany" is one of the odd fifty aboriginal American words, —so many of them denominating economic vegetable products [caoutchouc, cocao, chocolate, copal, guava, guaicum, ipecacuanha, jalap, quinine, tapioca, &c.] —that have become part and parcel of the "all a growing, all a blowing," ever youthful, and world-masterful English language. Its English names are Bastard Cedar, Red Cedar, and "Chittagong Wood." [See Nos. 4 and 3.]

5. *Cedrela Toona*, Roxburgh; an evergreen forest tree extending from Western India, where it uplifts itself gloriously in the ravines of the *ghats* [Sahyadri hills], to Eastern Bengal, and far into Burmah; with flowers used for dyeing a deep-toned red; a febrifugic bark; and a red wood. The timber is in no way inferior to Mahogany, and has apparently been immemorially famous in all the countries washed by the waves of the Indian Ocean, and enriched by the commerce of India; for I recall here, as I write, reading in the *Athenæum* of the 15th, 22nd, and 29th of July, 1837, in a series of *illustrated* articles,* which enchanted me as a boy, and have ever since held me in their enchantment [I wonder who wrote them?] that the frame of an Egyptian harp in the Museum of Florence, is of "East Indian mahogany," "the strings of the harp being strung to a large harmoniacal body of this wood." It is the Sanskrit *tuna, i.e.*, "causer of belly-ache [to elephants];" the Telegu *nandi-vriksha, i.e.*, [causer of] happiness tree [to Brahmani bulls];" and Malabari *arana* [*aranya*, a forest], *i.e.*, derivatively, "fire—lighting—by the clashing of its branches together—tree." The English names are—"East Indian Mahogany," "Indian Mahogany," "Bastard Cedar," "Indian Cedar," "Maulmein Cedar," "Singapore Cedar," "White Cedar," and "Chittagong Wood." [See Nos. 3 and 4 above.]

6. *Chloroxylon Swietenia*, De C.: *Swietenia Chloroxylon*, Roxburgh: a small deciduous forest tree of Western India, and the whole Malabar Coast, particularly in the neighbourhood of Gokah, and the "Allabella Hills;" with a hard, durable yellow wood of fine grain, and an exquisite satin-like lustre, from which it takes its English name of Satin Wood. Its other English names are Woodoil Tree and Zante Tree. This last may be a doublet of Satin; a designation derived from Zaitun, the Chinese emporium from which glossy silks were first exported to Europe. The phrase has nothing to do with the island of Zante:—any more than the Mahogany of the West Indies can have anything to do with the Cedar used by King Solomon in the building of the Temple of Jerusalem. It is remarkable, and inexplicable, that there are no individual, distinctive, and exclusive Indian names of the Satin-wood Tree, all of its few Indian names referring to some comparison of it with other trees or their products.

7. *Khaya senegalensis* is another Meliad or Cedrelad, the source of the African Mahogany, or Senegal Mahogany of commerce.

Madeira Mahogany, Mountain Mahogany, Queensland or Swamp Mahogany, and White or Wild Mahogany, are but curiosities,—mere "shadows of a mighty name"; interest attaching only to Madeira Mahogany, from its being the product of a Laurel-bloom of the West Indies, *Persea indica*, which would flourish well in the East Indies within the range of the sea-breezes.

GEORGE BIRDWOOD.

11th July, 1908.

* Founded, I learned in after years, on the works of Heeren, Rosellini, and Cailliaud.

PRESERVATIVES IN MEAT FOODS.

Some time ago the Local Government Board decided that enquiry should be made into the circumstances which led to the presence of preservative agents in canned and glass-packed meats, and Dr. A. W. J. MacFaddan was directed to make the necessary investigations. He has now submitted his report, and it cannot be said that it disposes of the popular idea that these preservatives are used and are not harmless. It is to be noted that whilst the Chicago and other revelations as to the quality of canned meats led to the general belief that American canned meats were much inferior to those made in England, Dr. MacFaddan's investigations point to preservatives being much commoner in England than in the United States. It may be pointed out that, with certain possible exceptions, there should be no need for the addition of chemical antiseptics at the time of preparation of the meat for canning, and that the meat which is canned should ordinarily be fresh meat or cured meat, not meat which has been subjected to treatment involving the introduction of preservatives such as boric acid or sulphites. Meat foods of this kind which have been submitted to a process of sterilisation in hermetically sealed retainers should be, as Dr. MacFaddan points out, sufficiently protected by this means from processes of decomposition so long as they remain unopened. If, therefore, these preservatives are found, the inference is irresistible that the meat had ceased to be fresh before it was canned.

According to London representatives of United States packing houses, it has never been the practice of American packers to add preservatives to meat for canning purposes, and the addition of preservatives to canned goods intended for export is not now practised and has never been contemplated; but Dr. MacFaddan's investigations do not confirm these statements. A table he gives in his report shows that a considerable proportion of the American samples examined were reported to contain preservatives either in the form of sulphite or boron compounds. The quantities of boron compounds found,

however, were for the most part small, varying from "traces" to quantities estimated at 5 or 6 grains per lb.

In many of the foreign countries and British dominions from which large quantities of meat supplies for this country are derived, chemical preservatives are not employed either in the preparation or packing of the meat products which are exported. Thus, materials of this kind exported from Argentina, Australia, and New Zealand, are invariably preserved simply by one or other form of cold storage. Some indication of the extent to which preservatives occur in canned meats manufactured in this country may be obtained from an examination of the reports received from public analysts in 1906. Dr. MacFaddan sets out the figures. He deals with 352 samples of tinned or glass food goods of British manufacture, and he finds that boron was found in 156 of them and sulphites in 12. The actual amounts estimated to have been present were in many instances also considerable, thus of boric acid the amounts estimated were in eleven samples between 20 and 30 grains per lb., in fifteen between 30 and 40 grains, in five between 40 and 50 grains, nine samples contained larger quantities namely 55, 56, 71·5, 74·2, 81, 110, 114·5, 145·7, and 163·6 grains per lb. respectively. In about 100 of the samples the amount of boric acid estimated varied from a fraction of a grain up to 20 grains per lb., and in the remaining samples which were said to contain boric acid either the amounts were not stated or the preservative was reported to have been present in "traces" only. The manufacturers examined by Dr. MacFaddan declared that whatever may have been done in the past, they no longer used preservatives to their products. As to why they used preservatives in the past, Dr. MacFaddan says their reasons were not always clear. Some stated that their object was to keep the meat from becoming tainted during the process of cutting up and preparing for canning. Others that the preservative was added to supplement sterilisation by heat, in case the latter process should have failed, and some again could give no reason other than that the recipe according to which the article was prepared had contained instructions to add so much preservative. Dr. MacFaddan considers that the tendency of adding preservatives to food materials of all kinds has been encouraged to a large extent by the manner in which manufacturers of the various boron antiseptics, and their agents, have pressed the claims of their preparations on those engaged in the various branches of the trade in meat food products. These antiseptic materials are often sold under fancy names, with nothing to guide the purchaser as to the composition, and are often accompanied by a sort of guarantee to the effect that their use, in accordance with the directions given, will not entail liability to prosecution. The great saving in trouble and material which is held out as an inducement to users of these substances, and the harmless, not to say beneficial effects which they are stated to have on those who consume them in food, have no doubt had weight with a certain class of preserved meat manufacturer.

It would seem from the evidence collected by Dr. MacFaddan to be indisputable that the use of chemical preservatives in foods enclosed in sealed cans and glasses is only necessary when the meat employed has already approached the verge of its keeping period, or when the processes to which it was subjected were conducted amid unclean or unwholesome surroundings. It is equally clear from the evidence upon which Dr. MacFaddan's report rests that preservatives are still largely used, the inference being that the food to which they are applied is not fit for human consumption. At any rate, there is considerable doubt as to whether it is fit. These conclusions would seem to point to the necessity for an amendment of the law, which would absolutely prohibit the use of preservatives in meat foods packed in cans or glasses.

THE OPENING UP OF WESTERN CHINA.

Tatsienlu, in the province of Szechuan, Western China, is the last town before reaching the Tibetan border. It is situated, at an elevation of 8,400 feet, in the high mountains that extend through Western China into Tibet. To reach Tatsienlu from Chungking it requires twenty-one days, and from there to the Tibetan line, eighteen additional days, the route crossing mountain passes over 15,000 feet high. Until the present dynasty the Tibetan boundary line extended as far east as Tatsienlu, but under the present *régime* it is now drawn eighteen days travel further west, at the town of Batang. As this border strip of territory is mostly populated by Tibetans, they are under the jurisdiction of three Tibetan chiefs, each having his district, but all under the sovereignty of the Chinese Government. Tatsienlu is a small town, with low wooden houses, and a population of 9,000, mostly Tibetans, and according to the United States Consul there, its strategical and commercial importance is due to its being the gateway to Tibet, and the high plateaus to the north-west. In this district are splendid grazing pastures where a fine quality of wool is produced. Farther on is the Tachin River, which forms the boundary between Eastern Tibet and one of the aboriginal Chinese tribes, called the Mantzu. A large trade is done here in rhubarb and musk, the latter taken from the small hornless deer, plentiful in this part of China. Of the exports from this district, musk is the most valuable, the price of the medium quality being thirteen times its weight in silver. The product is obtained from a sac-like gland in the abdomen. It is carefully dried, and sewn in small bags, called musk pods, of one ounce each, made from the skin of the animal. The musk deer of North-Western China is an allied species, and is only found at an elevation of

over 8,000 feet. It stands about twenty inches at the shoulder, but its chief characteristic is the absence of antlers in both sexes. The males have tusks protruding from the lower jaw to a length of three inches. The species is known as the *Moschus Sifanicus*. Wool comes next in importance as an article of export. The trade in wool, however, has diminished of late, owing to the disturbances on the border. The coarse, sack-like wool cloth, "mu-tiz," is worn by all Chinese coolies, while a fine grade, dyed red, called "pulu," is the clothing of the higher class of Tibetans. The lower classes, such as yak and pony drivers, wear entirely undressed sheepskins. About 45,000 pounds of wool are received annually in Tatsienlu. Gold is known as "Huang huo," and is brought for sale in the shape of dust, though sometimes nuggets are found. From 5,000 to 7,000 ounces come to Tatsienlu annually. The Tibetan confines mining to washing the alluvial sand in the river beds. He is averse to outsiders mining in his country, his antipathy to them being very marked. The Tibetan wishes to be let alone, and strongly resents foreign intrusion. The exports from Western China to Tibet consist almost entirely of tea. The shipments *viâ* Tatsienlu come principally from the town of Yachow, in Szechuan Province. The tea packages are made in rolls about three feet long. Each carrier will take on his back from five to thirteen, according to his age and strength. The annual value of the trade is somewhat over £150,000. The taxation amounts to 20 per cent., the bulk of which goes to the salt and tea "taotai" at Chingtu, the capital city of Szechuan Province. A French railway is in course of construction from Pakhoi, on the Gulf of Tongking, to Yunnan, the capital city of the province of that name, in the south-west of China. When completed it is proposed to extend it to Batang, a distance of about 400 miles. If this is done it will give Eastern Tibet and Western China an all-rail route to the sea, and divert the traffic from the long and laborious route *viâ* the Yangtze River. From Batang to Suifu, the head of navigation of the Yangtze, ia a march of thirty-two days over the mountains, some of which are 15,000 feet in height. From Suifu to the mouth of the Yangtze at Shanghai is a distance of 1,600 miles, including the gorges and rapids of the upper part of the river.

TURKISH BITUMEN.

Bitumen in Turkey exists principally in the province of Aleppo and Syria. The caiza of Saida contains deposits in the vicinity of Ain-Tadjoura. These deposits are also to be found in the villages of Ain-Ebel, Aidib, and Hereika, at various places in the sandjak of Acre (St. Jean d'Acre), near Antioch, and at Latakia. In Syria, the bituminous pits of Hasbeya are the most noted; at Somar and Ain-el-Tin these deposits are no longer exploited. In 1897 the Sultan leased to a Beirut firm the right to work these bitumen deposits on a basis of one-third of the product mined to the concessionaire, and two-thirds to the Government. In 1895, the total quantity mined amounted to 600 tons, of a total value of about £14,000. The average amount exported from Saida amounts to 370 tons. The bitumen from Judea is generally in large pieces mixed with earthy substances—limestone, clay, and sand. It is worth as much as £37 per ton, according to the American Consul-General at Constantinople. It rarely contains oxygen, but it always contains sulphur. Judean bitumen floats, in pieces of varying size, on the dead Sea, and is washed up principally on the western shore, where the Arabs collect it. The bitumen rises from the depths and forms islets, which were remarked in ancient times and described by Strabo. The local earthquakes have the effect of augmenting these deposits. In the year 1834, after a severe shock of earthquake, a mass of 20 tons was thrown up on the southern coast; in 1837, when a sharp shock was felt all over Syria, a mass of 15 tons came to the surface. The bituminous deposits of Judea, from the southern extremity of the Dead Sea to the source of the River Jordan, lie in a remarkable manner along an axis parallel to that of the basin. The deposits along the western coast of the Dead Sea to the River Jordan, are the following—Waddy Sebeh, Waddy Mayawat, Nebi Musa, and Hasbeya at the northern extremity of the River Jordan. Other deposits are known to exist, principally around Tiberias, but they have not been the subject of any special study. The impregnations are found in cretaceous surroundings. At Nebi Musa and Hasbeya these are white and soft, and contain numerous fossils. The deposits are generally well defined, and of limited extent. Impregnation ceases gradually as the limestone becomes more argillaceous. The impregnated limestone, rich in fossils, is either a brownish colour, as at Hasbeya, or of a rich black, as at Nebi Musa. When exposed to the sun, they lose their superficial colour, while on the surface they are only distinguishable by a faint bluish colour of the surrounding chalky clay, and at times are passed unnoticed. The limestone in the vicinity of the bituminous deposits is often marked with numerous veins of gypsum, and also contains a large proportion of chloride of sodium. The deposit of Waddy Sebeh, of minor importance, is composed of dolomitic limestone, impregnated with bitumen. The person who rediscovered it, compares it to the ancient description by Strabo of the rocks exuding pitch. The stream of Waddy Sebeh has forced itself a passage across this calcareous region, and down the river, and in the bed of the stream fragments of asphalt are often found, these being, no doubt, torn away by the waters from the calcareous bituminous regions it traverses. The deposits of Waddy Mahawat are situated not far from the saline deposits of Djebel Usdom, and at about 300 yards from the mouth of the Waddy Mahawat stream. The cretaceous limestone is here strongly impregnated with bitumen. It oozes from the fissures, and at times takes the form of real

stalactites. The alluvium attached to this limestone is also impregnated with bitumen. The stream of Waddy Mahawat traverses this deposit, and carries with it fragments of this bituminous conglomerate. The deposit of Nebi Musa is the most extensive of all. It shows itself on the surface in large blueish patches, which expose a bituminous limestone of a beautiful black when cracked. The deposit of Hasbeya, situated at the northern extremity of the Jordan, is one of a series of deposits absolutely analogous to that of Nebi Musa, which stretch along the Anti Lebanon. The bituminous limestone of Hasbeya is brown, and not so rich as that of Nebi Musa. At the time of the Egyptian conquest it was the seat of regular workings, and the remains of some twenty pits may still be seen. Apart from these various deposits, there has already been mentioned, under the name of Judean bitumen, the bitumen which floats on the Dead Sea, and which would appear to originate from thermal sources in this lake bed.

RUBBER PLANTING IN SAMOA.

The large results which have been attained with hevea culture in Ceylon, the Malay Straits, and the Straits Settlements, have induced the planters of Samoa to turn their attention to rubber planting, and it is expected that within a few months 300,000 hevea trees will be planted out in the island. The importation of 100,000 hevea plants into Samoa from Ceylon as so-called "stumps" has been a complete success. The difficulty in obtaining hevea plants has been solved. How it will stand as regards disease, especially the *Limumea*, and what yield the rubber will give in Samoa, cannot be forecasted. According to the report of Mr. Acting Vice-Consul Trood on the trade of Samoa, just issued (No. 4017, Annual Series), there are three large rubber plantations now in existence in Samoa. The first has several thousand acres, the second 800 acres, of which half are cultivated; and the third, 350 acres in rubber and cacao, and 100 acres in rubber solely. All promise excellent results when the trees are ready for tapping. The great advantage which Samoa enjoys over the adjacent islands is that it is subject to hurricanes only at extremely long intervals. There has been no severe storm since 1889, and even if a hurricane should take place within the next few years, it is pretty certain to be followed by a period, varying from 25 to 30 years or more, during which there will be no gale worth mentioning. The rubber tree has no very great power of resistance against storms, and Dr. Preuss, who has been making a study of the question of rubber-growing in Samoa, suggests that the plantations should be provided with wind breaks, for which purpose the *Ficus elastica* is best suited. This tree grows quickly, spreads out widely, and forms a full thick crown. It has great resisting powers against wind, and, besides, gives a yield of first-class caoutchouc.

HOME INDUSTRIES.

The Carpet Industry.—The present condition of the British carpet industry is one of considerable depression, and there is little likelihood of early improvement. Up to the end of last year manufacturers had been confronted by a steady rise in the cost of raw materials from the level of 1901-2. Advances were made in the priee of goods from time to time but they were hardly adequate to cover the increased cost. During this year there has been some easing of prices of raw material. Unfortunately it has been concurrent with great slackness of demand, a slackness which is likely to continue. The truth seems to be that people do not spend the money upon floor coverings that they used to spend. They are content with inferior and often foreign carpets, and they prefer to spend time and money in hotels, restaurants, and motor-cars, rather than to pay, as they used to pay, for the adornment of their homes. That is one and an important factor. Then there is the foreign competition which seems to grow more active every year. The Oriental seamless hand-made carpets, made in a wide variety of qualities and prices, compete directly with the better of the British hand-made fabrics, while the cheapest makes come directly against various qualities of machine-made seamless squares and with some of the better qualities of breadth goods. The Oriental competition is formidable mainly because of price, and the low price is due to the low cost of labour and the conditions attending the manufacture. Then again large quantities of carpets are imported from the Continent, chiefly Wilson and Axminster piece goods and Chenille seamless squares which are sold at prices with which the British manufacturer cannot compete. On the other hand the British maker finds what may be called his fixed charges, such as rates, taxes, coal, labour, and insurance, constantly growing. The only way to improve his position is to increase the price of the article he sells, but the public is not easily got to pay a higher price for a standard article than it has been used to pay, and if the manufacturers insist upon it, the competition of the Oriental and Continental producers will probably grow more formidable even than it is at present. Altogether the outlook for the British carpet manufacturer is disquieting.

The Supply of Meat.—During the last few months there has been an advance in the price of beef to something like 40 per cent. from normal prices. Experts lean to the opinion that the maximum price has been passed; but whether that is so or not, the present price is abnormally high, and has naturally quickened the discussion, always more or less active, as to the wisdom or otherwise of the embargo on Canadian cattle. The advance in the price of beef is admittedly due to the restricted sources of supply, the result in some part of the financial crisis of last year in the United States, but due, too, as some contend, to the domination of the American packers in our big distributing centres. It is urged that the

only means of competing successfully with them is by allowing Canadian cattle free entrance, and it is pointed out that for years past Canada has shown a clean bill of health. On the other hand it is urged that the present situation in the meat trade has little to do with the exclusion of Canadian store cattle. If the American packers dominate the market it is mainly because they are the largest buyers of cattle, and proof is lacking that they have made prices in this country artificially high, and that store cattle could have been imported cheaply but for the embargo, or that our own pastures could have profitably fattened the imported animals in addition to the native and Irish store cattle. This argument receives some support from a statement in the Board of Agriculture's report of a fortnight ago, which says, "many grass-fed beasts are being put on the market in an unfinished condition, owing to the shortness of keep and meat with a poor demand at a very little over 6d. per lb." The question is one of great importance to the public. Expert opinion is sharply divided upon it, and the suggestion that the Government should appoint a Commission to enquire and report upon the matter seems to be one in support of which much might be said.

"*Dyer's Faults*."—In periods of slack trade, complaints as to what is called "Dyer's Faults" are apt to be frequent. "Off shade" is a very usual cause of complaint, and there is often enough truth in it to enable the merchant or manufacturer to obtain a substantial allowance. A correspondent of the *Manchester Guardian* suggests that the difficulties of the dyeing trade, as a whole, are much increased by the action of a few dyers who make use of that class of dye stuffs, named "chameleon." Fabrics dyed with them present a very different shade when viewed by artificial light, from that which they possess by daylight. A covert coating dyed in this way may be a decided drab by daylight, and a fairly bright green by gaslight. The shade changes in less degree with the varying intensities of natural light. Thus a dyer who uses good sound dye wares may receive a pattern died with "chameleon" dyes to which he may make an excellent match at 10 o'clock a.m. The goods are examined at the merchants a few days later at 4 o'clock p.m., and returned to the dyer as "off shade." It is impossible for the dyer to say that the shade should be examined at 10 o'clock a.m., or at whatever other hour the goods were dyed. The only means of obtaining an exact match at all hours is to use the same inferior dye stuffs, and thus perpetuate the trouble. No elaborate test is required to distinguish the "chameleon" dyed pattern if it be examined first by daylight and then by the light of a match, the difference is usually pronounced, particularly if compared under similar conditions with a pattern which is known to have a constant shade.

The Coal Trade.—The fate of the Eight Hours Bill remains in some doubt. Whilst it is strongly supported in some quarters, it is opposed with equal vehemence in others, and the fact that the miners themselves are not as one on the matter deprives the promoters of the Bill of the support that is so invaluable when it is given by a great and united industry. In a letter to his constituents, Mr. Thos. Burt, M.P., who has always been an opponent of the proposal, intimates that in consequence of the change of attitude on the part of the Northumberland miners who are now supporting restriction, he will not any longer oppose it. So far as Northumberland is concerned, it is not wanted, at any rate, there is no such need for it as there is alleged to be in other parts of the country, where, as its supporters assert, large numbers of men and boys are underground day after day for 11 and even for 12 hours out of the 24. How enormous the coal trade of the country has become may be gathered from the fact that the aggregate production in 1907 amounted to 267,000,000 tons, or 16,000,000 more than in the preceding year. The increased output has of course necessitated drawing further upon the labour market. According to the report and statistics of mines and quarries for 1907, the number of miners employed both underground and on the surface totalled 940,000 as contrasted with 882,000 in 1906. These figures represent an addition of 58,000 workers in a single year. All the producing districts participated in the increase in the output in 1907, the Midlands coming first with the largest increase.

"*Shopping Trains*."—One of the big London "department stores" is making the experiment of a shopping train, and if it succeeds other houses will no doubt follow the example set. The proposal appears to be in the nature of an arrangement between big London shops and railway companies for special excursion trains to be met by conveyances which would conduct the excursionists to the premises of the firm running the train. Naturally, the retail trader in the country is indignant at this new attempt to take from him some portion of his already diminishing custom. The tendency of the times is undoubtedly to increase London business at the cost of the provinces. The facilities of travel and of carriage greatly assist this development. Nor is it easy to see how it is to be completely stopped by the provincial trader. Obviously, the best possible course for him is so to add to the attractions of his shop that there should be no inducement to the people of his district or town to travel to London for what they want. But this is easier said than done. The customer is not averse to a run to London when it is within measurable distance of his home, and can be undertaken at small cost. There is still a sort of glamour about London in the eyes of customers. They think, often no doubt incorrectly, that London goods are more up-to-date than those displayed in their own town, and the parcel post, and the shopping train, and other devices of the London trader must, it is to be feared, continually increase the cus-

tom he contrives to wrest from the provinces. It is much to be regretted that it should be so, for no one can view with pleasure the decay of trade in the provinces owing to undue concentration of business in London.

OBITUARY.

Lord Blythswood.—Lord Blythswood, who had been a Member of the Society since 1888, died at Blythswood House, Renfrew, on the 7th inst. He was the first holder of the title, which was created in 1892. Lord Blythswood was born in 1835, and was the son of Archibald Campbell of Blythswood. He served with his regiment, the Scots Guards, in the Crimea, and retired as Lieutenant-Colonel in 1868. He was in Parliament for some time as Member for Renfrewshire and West Renfrewshire, until his elevation to the peerage. Lord Blythswood was a devoted student of Science, and did much useful work, especially in Physics. After the discovery of Radium, some interesting experiments were carried out in the laboratory which he equipped at Blythswood. He had also many other interests, was an ardent supporter of the volunteer movement, a leader in county politics, and an active sportsman.

GENERAL NOTES.

British Capitalists in Egypt.—The success of the recent Paris Loan in aid of the Credit Foncier Egyptien, and the readiness of French capitalists to subscribe another Loan if Egypt really wants the money, has encouraged the formation of two English concerns to conduct banking and financial business in Egypt. One is a Mortgage Bank, with a capital of one million, and it is said that Sir Ernest Cassel, Sir William Garstin, and Lord Milner will be members of the Board. The main business of the Bank will be to conduct mortgage business for the development of land, such business as the National Bank of Egypt is unable to undertake. The second enterprise is a Mortgage Guarantee Company which will guarantee the interest and principal of loans on land, and this too is understood to have powerful support. If these two projects come to fruition they should do not a little to restore the balance of British financial influence in Egypt.

Relief Map of Colorado.—The State of Colorada is preparing for exhibition at the International Congress on Tuberculosis to be held at Washington, in the autumn, a large scale relief map of the State, which is stated to be the most important map of the character yet produced in America. The cost of the map is estimated to be several thousand dollars. It is being made in eight sections. The total size of the map, when the sections are put together, will be 16 feet East and West by about 11 feet North and South, giving a total area of 181 square feet. The horizontal scale is two miles to the inch. The vertical scale is described as being on a new graded scale, different for each thousand feet, that is an exaggeration of two to one at the tops of the mountains, say 14,000 feet altitude, gradually increased in exaggeration to ten to one at 6,000 feet, and fifteen to one below 5,000 feet. The map is to be painted in such a way as to represent Colorado in the autumn, when the mountains are covered with snow and the trees have not lost their foliage. The railroads, towns, &c., are all to be shown in colour.

Porto Rico Coffee.—Up to the time of the American occupation coffee held the premier position among Porto Rican products, but owing to the rapid advances made in sugar and tobacco, and the lack of any protection in the United States markets, such as is enjoyed by the other two products, the coffee industry now takes third place in the island. With the American nationalisation Porto-Rican coffee lost its favoured Spanish markets, and ever since has had to compete in its new natural outlet (the United States) with the duty free South American berry, on even terms. It is estimated that there are some 16,000 coffee plantations in Porto Rico of all sizes, of a total acreage of about 19,000 acres, all in the mountainous districts. Very little life is now shown in the coffee industry owing in a great measure to the persistence in retaining old methods of developing and curing, and also to the discouragement in failing to find remunerative markets.

Rubber in Mozambique.—Reporting on the trade and commerce of Mozambique, Mr. Consul Maugham refers to the exports of rubber and to the "cooked" quality of much of it. Hamburg has been for many years past the market for Mozambique rubber of this quality, a steady demand having existed there for all qualities. During 1905-6 the British Indian dealers were induced to buy very largely from the native quarters, and the increased demand has given rise to much adulteration by these latter, who have not scrupled to mix all manner of foreign bodies with the latex and to such a large extent that consignments exported instead of realising 1s. 6d. to 2s. 3d. per lb., as they did for so long, were found on arrival in Europe to be either unsaleable or were disposed of at 6d. to 8d. At the present time, Mozambique "cooked" rubber is not marketable in Hamburg or London, while several sellers have endeavoured to dispose of their depreciated stocks. It is felt to be most regrettable that the export of this article should have been permitted, as the prices realised in the centres mentioned do not serve to cover expenses of freight and customs, and large sums have been lost by local Indians from this cause.

Journal of the Royal Society of Arts

No. 2,905. VOL. LVI.

FRIDAY, JULY 24, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

FUEL AND ITS FUTURE.

By Professor Vivian B. Lewes.

Lecture II.—Delivered March 16, 1908.

Having gained an idea of the wonderful actions by which Nature has stored the sun energy of long past ages, and stored it in such a form that by combustion it can be converted into sensible heat, it will be well to glance at such figures as can be obtained as to the distribution of coal and the rate at which it is being consumed.

Not only has America the largest store of coal in the world, but it has the further advantage that the amount that has been mined is comparatively small. It is only of late years that the output of coal has been in proportion to the magnitude of her coalfields, but in the last year of the past century she deprived England of her position as the world's greatest producer, and now is easily first, raising at least a third more than is done in the United Kingdom.

Leaving America to look after her own vast interests, let us see how the ratio between capital and expenditure compares for the chief European powers, taking them in order of coal production :—

	Production per annum.	Total coal, millions of tons.
Great Britain ..	236,130,000	.. 140,000
Germany	119,350,000	.. 150,000
France	34,780,000	.. 17,000
Belgium	21,500,000	.. 16,000
Russia	17,120,000	.. 20,000

Such figures can only be the merest approximation, but if they are of any value at all they mean that we are the spendthrift of Europe, and that our supremacy is at the cost of such capital expenditure that, unless we take the position seriously and do everything in our power to retrench by economising much of the fuel now wasted, it is evident that before many generations have passed we must lose our priority amongst the European nations.

At the present rate of use our coalfields would be exhausted in a little over 600 years, which seems at first sight to be a fairly comfortable reflection, but it is clear that the use of coal will go on increasing until shortage and consequent rise in price checks the demand. Although the demand may not be in the enormous proportion that has characterised the past ten years, yet it would be absolute folly to expect it to remain at the present figure unless drastic steps are taken to prevent waste. Moreover, it is manifest that the cream of the coal supply has been utilised, and that a very large proportion of the existing supply is at greater depths and in thinner seams than that which has been used in the past, and must of necessity, therefore, entail much greater expense in winning. It is therefore clearly not the remaining amount of coal which governs the question of relative power, but the price at which that coal can be commercially used. Although it may be possible to prove by statistics that our coal supply will last for 600 years, it is quite within the range of possibility that, if the increased consumption continues, a period may come within a very few generations when the cost of coal has so risen as to enable foreign markets to obtain coal at a cheaper rate than our own supply. Even at the present moment a few shillings increase in the price of coal would have a tendency in this direction.

It is clear that the country is living upon its capital, and under the existing conditions increase in commercial activity really tends towards the destruction of the main factor in our well-being. Although the same conditions exist in other countries to a certain degree, there is not the slightest doubt that our trade rivals are taking advantage of all

possible economies to a much greater extent than we are.

At the present time Germany seems to be the popular bugbear in the public mind, and for that reason one feels almost ashamed to say anything that might be construed into an attempt to foster that feeling, but a little consideration must show that Germans are undoubtedly our great trade rivals, and that we are playing into their hands in a way that is perfectly indefensible. Germany's present store of unwon coal is now practically the same as ours, but the amount they raise is only half, although their annual rate of increase has been much greater than our own, still, at the present rate of supply, if it remains constant, the German coal will last for double the time of ours, that is, if the life of our coal supply is 600 years, theirs will be 1,200. The conditions existing in Germany are all of a character to sap slowly but surely our strengh and resources.

At the present day there are collieries in England, one alone of which brings to the surface over a million tons per annum of some of the best coal in the country, not one ton of which finds its way into the English market, but is all exported. This coal is able to compete with German coal in price right up the Rhine close to the principal German coalfields and as far as Mayence. The total amount of coal exported from this country is over 20 per cent. of the coal raised, and supposing that the life of our coal supply were 600 years, this item alone means 120 years. It must be remembered, however, that a good deal of the exported coal is for foreign coaling stations, and is used by British ships, but something should certainly be done to prevent the depletion of the coal supplies ot the kingdom to supply trade rivals.

It would be madness to advocate anything which would check or cripple our commerce in any way at the present time, but it must be clear to everyone that in the interests, not only of the country, but of each individual in it, everything should be done which could tend to economy in the use of coal. If the individual units in our Empire would only realise that by slightly altering their methods of fuel consumption, they could not only obtain the same manufacturing results, but do so at greatly reduced cost, and at the same time purify the atmosphere, a time would soon come when the health and wealth alike of the country would be benefited.

The Royal Commission on Coal Supplies of 1905 compiled statistics as to the proportion of the coal raised that was utilised for various purposes, which may be represented in percentages, as follows :—

	Per cent.
Factories	22·97
Domestic	13·87
Iron and steel manufacture	12·17
Mines	7·80
Gas works	6·50
Railways	5·53
Potteries, brick works, glass works, and chemical works	2·16
Metal and minerals	·43
Coasting steamers	·87
Steamers over seas	7·25
Exported	20·35

Bearing in mind the distribution so shown of the consumption of fuel, it will be well now to glance at the directions in which economy is possible, and the extent to which such economies would reduce the total consumption.

England suffers to a great extent from the stolid adherence to old ideas and methods which have served her well in the past, and which she hesitates to throw aside; and many commercial firms still cling to the procedure of their founders until they find they can no longer hold their own with the products of more up-to-date processes. Trade once lost is hard to regain in these days of keen competition. In America and Germany, directly an improvement proves its worth, no hesitation is shown in scrapping obsolete machinery or relegating wasteful processes to oblivion; and although in certain branches of trade we are beginning to adopt progressive methods, much remains to be done, and in no direction is there greater scope for improvement than in the production of power and generation of heat.

It is not enough to know the calorific value of a fuel—one must know the work it has to do and be able to fit the fuel to that work, before true economy and success can be attained, and it is for this reason some fuels, so poor in calorifics as to have been hardly considered until lately, have achieved the greatest success, whilst others of many times the heating value have been more successful in fouling the atmosphere than in doing the work needed.

The fuels we have at our disposal for the commercial generation of heat may be tabulated as follows, together with their calorific values :—

Average Thermal Value of Fuels.

Solid Fuel.

	Calories.		British Thermal Units.
Coal—			
Newcastle	8,446	..	15,203
Welsh	8,402	..	15,123
Lancashire	8,113	..	14,602
Derbyshire	8,120	..	14,616
Anthracite	8,677	..	15,619
Coke—			
Oven coke	8,020	..	14,436
Gas coke	7,900	..	14,226
Peat—			
30 per cent. water	3,000	..	5,400
20 ,, ,,	4,000	..	7,200
10 ,, ,,	5,000	..	9,000
5 ,, ,,	5,500	..	9,900
Wood (average)	4,818	..	8,671
Charcoal	8,137	..	14,646

Liquid Fuel.

Petroleum (fuel)—			
American	10,904	..	19,627
Russian	10,800	..	19,440
Texas	10,700	..	19,242
Caucasus	10,340	..	18,611
Borneo	10,461	..	18,831
Burmah	10,480	..	18,864
Petroleum spirit	11,624	..	20,923
Shale oil	10,120	..	18,217
Blast furnace oil	8,933	..	16,080
Heavy tar oil	8,916	..	16,050
Alcohol absolute	7,184	..	12,931
,, 10 per cent. water	6,400	..	11,520
,, 20 ,, ,,	5,700	..	10,260
,, methylated	6,200	..	11,160
Gaseous fuel—			
Natural gas	12,008	..	21,615
Coal gas (London 16 c.p.)	10,666	..	19,220
Water gas	4,430	..	7,980
Mond gas	1,402	..	2,525
Dowson gas	1,310	..	2,353
Suction plant gas	1,200	..	2,160
Air-coke gas	540	..	972
Blast-furnace gas	528	..	951

The calorific value of a fuel, however, is chiefly of use in giving a comparison between the fuels themselves, and in its utilisation we must take into consideration the work which that fuel has to do and how far it is fitted to that work. If we were restricted to the use of coal and required a high local intensity for the fusion of a metal in a furnace, anthracite, which burns with hardly any flame and gives great local heat during the combustion of the high percentage of carbon it contains, would be manifestly the best fuel to employ, whilst if one required a considerable volume of flame to generate heat in the combustion chamber and tubes of a marine boiler, we should find that the more bituminous coals, although giving plenty of flame, would at the same time give too much smoke. Natural fitting of the fuel to the work would eventually lead to the adoption of Welsh steam coal, which would give us a maximum of heat and flame in the furnace and tubes with a minimum of smoke from the funnel; that is, we should by a practical process of elimination arrive at the point at which we could get the highest efficiency from the fuel. When, however, we came to make up the balance-sheet of thermal units which we had first of all utilised in the generation of steam and then converted into power by means of the marine engine, we should find that it would be only a small proportion of the energy latent in the coal which had been translated into work, so that the real question for solution would be more dependent upon the suitability of the fuel; that is, the ease with which it could be used and the amount of power that was originally in it.

During the first half of the last century it was solid fuel only that was employed for the generation of heat and power, but the last half of the century has seen the advent of liquid and gaseous fuels, which, under certain conditions, proved themselves of the greatest value. Certain processes are now largely dependent upon their use, this being due to the ease of application, which has meant economy in labour and greater facility for converting the heat into work. As an example of the ease of application making a fuel of poor calorific value more effective in use than coal of high quality, one may instance such manufactures as those of glass, where in the heating by solid fuel the necessary temperature had to be imparted to the mass of raw material through the walls of a thick fire-clay retort, the difficulty of application here being dependent upon the fact that the crucible had to be heated to a very high temperature to get the necessary fusing point of the glass mixture. Maintaining this for a considerable period meant a big expenditure in fuel and great wear and tear to the furnace and containing vessel. It was clear that if the solid fuel could be gasified, and the clean flame made to play directly on to the surface of the mixture to be fused, instead of having to impart the heat through the walls of the containing vessel, an enormous economy would be obtained, and this is now done by the utilisation of producer gas and regeneration in the continuous tank processes.

In the same way liquid fuel, as soon as methods could be found for its proper combustion, presented such wonderful economies and advantages for marine work that, in spite of its being dearer than coal, it at once found a place in both the Service and the mercantile marine. The possibility of being able to store it below the level of the boiler in the ballast tanks instead of having, as in coal bunkers, to have the storage above that level, at once gave increased space in the important part of the vessel, and, what was of much greater importance in the Service, the being able to carry a larger supply of latent energy in the same space as the coal occupied increased the radius of action of the vessel.

Other important economies, such as the amount of labour required and the ease with which fuel could be taken on board not only when alongside but from barges and other vessels when afloat, all tended to economy in use, and the only reason for its not having been universally adopted for Service purposes is that the world's supply of fuel oil would not be sufficient to meet the demand of the navy as well as the other demands for it, whilst being largely dependent for our supply upon foreign countries might prove disastrous in time of war, with the result that it is only employed as an auxiliary to, instead of entirely replacing, coal.

The total oil output of the world may be taken as being about 20 million tons per annum as against 800 million of coal, and of this oil at best only one-third is available for fuel purposes. The crude oil, as it comes from the well, would be absolutely unfitted for use, as in most cases it gives off inflammable vapours at air temperatures, and these mingling with the air form highly explosive mixtures. The temperature at which such inflammable vapour is evolved is called the "flash point" of the oil, and for use in the British Navy, no oil with a flash point below 200° Fahr. is allowed on board, although in the German Navy and the mercantile marine, the limit is fixed at 150°. This necessary limitation means that the crude oil, as it comes from the well, has first to undergo a process of distillation, the more volatile portions yielding petroleum spirit or petrol, employed in motor cars, &c., whilst higher fractions flashing above 73° Fahr. form the lamp oil, used for illuminating purposes. With most crude oils it is only the residue, which from American oil is called "residuum," and from Russian oil "Ostatki," that provides fuel oil supplies.

Besides the American and Russian oil fields, oil has been found in almost all portions of the globe, but although the distribution is probably as wide as that of coal, the amount obtained outside the American and Russian fields is only about one-tenth of the total output. In addition to the natural petroleums, shale oil and the oil obtained from tar on condensation from the blast furnace can be obtained, but the present supply of these is so small as to be negligible.

Not only does the use of liquid fuel for marine purposes present great economies in labour and storage, but weight for weight it is, when properly used, of considerably higher evaporative power; and the following Table gives the results obtained in practice with the same boiler, using various kinds of oil:—

Liquid Fuels.

	Specific Gravity.	Flash Point.	Calorific Value by Bomb.		Actual Evaporative Power from and at 212° F.
			Calories.	B.T.U.	
American Residuum	·886	350	10,904	19,627	15·0
Russian Ostatki	·956	308	10,800	19,440	14·8
Texas ...	·945	244	10,700	19,242	14·79
Burmah ...	·920	230	10,480	18,864	14·5
Barbadoes ...	·958	210	9,899	17,718	14·2
Borneo ...	·936	285	10,461	18,831	14·0
Shale Oil ...	·875	288	10,120	18,217	13·8

The type of boiler used, fired with Welsh steam coal, would give as its maximum duty an evaporative value of about 9 to 10 lbs. of water from and at 212° Fahr.

It is quite clear that if a national supply of fuel oil could be obtained which could be absolutely relied upon in time of war, the total replacement of coal in the Navy by liquid fuel would not only be an enormous advantage, but would mean the saving of an annual consumption of a million tons of Welsh coal in the Service alone.

Taking now the Table showing the percentage of coal used for various purposes, one sees that by far the largest percentages are used in factories and works where the coal is employed for the production of heat and power, and for these purposes it has now been realised that the gasification of the coal before use leads to such enormous economies that this procedure is almost universal in Germany, and has been adopted in many of the more up-to-date works in this kingdom, and the subject of power-gas production is one of the most interesting of the day.

The idea of making a poor fuel gas by passing air through a column of incandescent carbon in an enclosed generator probably dates back to Bischof's experiments in 1839, but was elaborated in 1857 by Siemens, and in combination with his system of regeneration it achieved a wonderful success, and revolutionised many manufacturing processes.

In the earlier form of generator the air was sucked by a chimney draught through a fuel bed, and gave a producer gas having a composition which varied according to whether coke or slack was used as the fuel in the way shown in the following analyses :—

	Coke.	Slack.
Carbon monoxide	29·0	22·6
Carbon dioxide	4·0	4·4
Hydrogen	2·5	7·8
Methane	—	1·5
Nitrogen	64·5	63·7
	100·0	100·0

The troubles and limitations caused by sucking the air-blast through soon gave rise to the idea of forcing air through by means of a blower, but when this was done it was found that the temperature of the fuel in the generator became so intense that troubles with clinkering and fusing of the furnace bars soon resulted, which, however, could be got over by injecting steam with the air into the fuel bed, and this could be conveniently done by using a steam injector in place of a blower. It was then found that the presence of the steam not only kept down the temperature in the generator to a point which could be regulated to a nicety by the amount of steam used, but also brought the calorific value of the gas formed up from 72 British thermal units per cubic foot to just double that amount, this being due to the decomposition of the steam by the incandescent carbon giving a large proportion of hydrogen to the gas. This so-called semi-water gas or Dowson gas has an average composition of—

Carbon monoxide	25·07
Carbon dioxide	6·57
Hydrogen	18·73
Methane	0·64
Nitrogen	48·98

and this gas, being found not only excellent for the heating of furnaces but also well adapted for use in the internal combustion motor, was capable of providing all the heat and power required in a works.

A modification of this method was employed by Dr. Ludwig Mond, and has proved itself very successful for the production of power in large works. In this process the temperature of the fuel in the generator is kept down by the use of large volumes of steam, no less than $2\frac{1}{2}$ tons of steam and 3 tons of air being used in the gasification of every ton of slack, and the great advantage of this method of working is that the nitrogen present in slack coal to the extent of about 1 per cent. becomes converted into ammonia, which can be extracted from the gas as ammonium sulphate by washing it in its passage through the scrubbers with dilute sulphuric acid. The sulphate of ammonium so formed is one of the most important manures for agricultural purposes, and there is an almost unlimited demand for it. The price obtained for the by-product makes the gas obtained in this way an extremely cheap form of power, but it only becomes economical when done on a big scale in works using about 4,000 horse-power.

One of the latest developments in large scale power plants is a modification of this apparatus which has been introduced by Messrs. Crossley, and, by doing away with some of the more cumbersome portions of the apparatus, gives great efficiency and simplicity to it.

The use of poor fuel gas for power production in gas engines, and the economy which they are capable of causing, will be fully discussed in the last lecture, but whilst dealing with gas for heat and power production it must be borne in mind that the gas made from coal by destructive distillation is after all next to natural gas the most valuable of the gaseous fuels, as it contains from three to four times the heating value of the semi-water gas, and the only thing which militates against its use is its cost. If only coal gas could be supplied at 1s. to 1s. 6d. per thousand, it would be one of the most valuable fuels for all purposes.

Water gas, which was first discovered at the close of the eighteenth century, and was made a commercial success only within the last 20 years, is a mixture of nearly equal proportions of hydrogen and carbon monoxide, produced by the passage of steam through incandescent carbon, and when made by such improved processes as the Dellwik, has now proved of enormous value for the welding of big tubes and for other purposes of that kind in which the application of solid fuel would offer many difficulties.

The conversion of a solid fuel, like coal, into gaseous fuel entails a loss of at least 20 per cent. of the heat units present in the coal.

For instance, taking a ton of slack with an average heating value of 15,000 British thermal units, one could make from it 11,900 lbs. of producer-gas, which would contain 25,704,000 British thermal units; but the coal itself would have contained 33,600,000, whilst if we had taken coke and had converted it into 2,600 lbs. of water-gas, this would have contained 20,748,000 British thermal units, and the coke, with its calorific value of 14,226 British thermal units per lb., would have been about 20 per cent. more.

When, however, we come to burn the coal by direct firing, we find that there are several factors which reduce the amount of heat that can be utilised to a small fraction of the original.

On first stoking the furnace fire dense smoke is at once seen to issue from the chimney, owing to the fact that the heat of the fire is distilling off gas and tar vapour at such a rate that a considerable proportion escapes complete combustion, the same action of distilling out the gas and vapour rendering latent a certain amount of heat, whilst the escape of products of incomplete combustion and even unburnt vapours and hydrocarbon gases, still further lowers the amount of energy that is converted into sensible heat. Then, again, double or treble the quantity of air indicated by theory has to be applied in order to get anything like complete combustion, and as this air consists of approximately only one-fifth oxygen, and all the residual nitrogen as well as the products of combustion are heated to a very high temperature, and are carried away up the chimney, this also means a heavy heat loss, and the final result is that it has been estimated that in a very large proportion of furnaces only 10 per cent., or even less, of the heat value of the fuel is actually used.

When, however, the fuel has been first gasified, the gaseous fuel requires only a comparatively small proportion of air to complete its combustion, and owing to its mobility in the gaseous state this air can be so completely mingled with the combustible gases as to ensure complete combustion taking place with very little more than the theoretical quantity of air, the loss of heat by distillation is avoided, combustion is complete, and the products of combustion being entirely gaseous and free from soot, the heat in them, instead of being carried away by the chimney, can be recovered in regenerative devices, and returned to the furnace. The result is that the total amount of heat utilised will be four or five times as great as when coal was employed, and this not only makes up for the loss of the 20 per cent. due to gasification, but leaves a large margin of economy and does away with the black pall of smoke, which, issuing from the factory shaft where solid fuel is used, forms a dense cloud over our manufacturing centres.

It must also be remembered that with direct firing each furnace has to be separately fed, and that although mechanical stokers and other labour-saving devices will reduce both smoke and labour, yet nothing can compete in a large works with the convenience and economy of gasifying the whole of the fuel used in a generator of a modified Mond type, recovering the nitrogen of the slack in the form of ammonium sulphate, and piping the gas through the area of the works for combustion in the various furnaces, whilst the gas serves not only for heating but for power purposes, when the economy in use is even greater than for furnace firing.

In enumerating the advantages and economies of gaseous fuel it is usual to lay great stress upon the fact that slack, smalls, and smudge are used, and that these, being of no use as domestic fuel, could be obtained at a very low price. A very curious phase of the fuel question, however, has arisen in that all the improvements in combustion devices having been designed with a view to utilising this cheap fuel, the result has been that in manufacturing districts the demand for it is now greater than that for sizable coal, so that it has risen in price to a point at which the vast economies attributed to it in the past have practically disappeared.

THE CONDITION OF THE WORKING CLASSES IN GERMANY AS COMPARED WITH ENGLAND.

One of the most striking observations in the report of an enquiry by the Board of Trade into working-class rents, housing, and retail prices, together with rates of wages in certain occupations in the principal industrial towns of the German Empire, is that where in referring to the condition of things in Berlin, the reporter says that the traditional and normal accommodation of working-class dwellings, and indeed of small dwellings generally, used to be "Stube, Kammer, Küche," or "Living room, bedroom, and kitchen," the living room having a stove, and the bedroom being without. When rents were lower than now, the "Stube" was used as a day room only, and corresponded to the downstairs living room in an

English working man's cottage. For a long time, however, the "Stube" has had to serve as a bedroom as well, since a dwelling of two rooms, a kitchen, and a room for all other purposes, has become the predominant working-class type in Berlin. Much is said, and probably correctly, about the improvement in the condition of the working classes of Germany during recent years, but in Germany, as in England, house rent presses very hardly upon the resources of the workman, and whilst in England there is no evidence that the workman has been compelled to be content with less house accommodation than formerly, in Berlin this is admittedly the case. In his Preparatory Note to the report, Mr. Arthur Wilson Fox points out the difficulties when a comparison is attempted to be made between the condition of the working classes in two countries which differ greatly from each other in the customs and standards of living of their inhabitants. For example, English rents of working-class dwellings usually include local taxation which is based on the rental value of the dwelling. In Germany local taxation is levied on an entirely different basis and is not included in rent. In regard to food, the British workman's meat consists mainly of beef and mutton, whilst pork (even including bacon) is relatively small in amount. The German workman, on the other hand, eats chiefly pork (including sausage) and beef, and only a very little mutton. The pure wheat bread eaten by the working classes of the United Kingdom is replaced in Germany either by pure rye bread or more commonly by some mixture of rye and wheat. These, says Mr. Fox, are only a few indications of the difficulties which arise in international comparisons.

There would seem to be little if any difference between the general level of rent in Germany and England, though rents in England include a considerable element of local taxation, whilst rents in Germany do not. Rents in Berlin exceed those of all the other German towns investigated (except Stuttgart) to practically the same extent as rents in London exceed those which prevail in other towns of the United Kingdom. The general level of prices is, however, distinctly higher in Germany than in the United Kingdom, and in this connection an important instance of the effects of differences in national habits may be noticed. The English working-man going to Germany and maintaining his accustomed standard of living would find his expenditure on food and fuel substantially increased, but in spite of the general higher level of prices in Germany, the German workman coming to England and maintaining his own standard would not find his expenditure reduced in a corresponding proportion. This is due mainly to the fact that the German workman takes much more than the English workman of certain food commodities, chiefly potatoes and milk, which are cheaper in Germany than in English towns.

The comparison of the rates of wages has been confined to certain standard trades in the United Kingdom report for the reasons stated in full in that volume. The general result of the comparison is to show that in German towns the workmen engaged in these trades receive about 17 per cent. less in money wages in return for a week's work of about 10 per cent. longer duration than the corresponding English workman. In other words, their rate of money remuneration is about three-fourths of the corresponding English rate, while the cost of food, rent, and fuel (measured by the English standard) is about one-fifth higher. With respect to unemployment, the official statistics issued in this country and in Germany respectively, are not comparable, as similar indices of similar facts. The German figures show a percentage of unemployed work people little more than one-third of that recorded by the British figures. One feature of German conditions is the existence there of a practice of resorting to some other industry for employment when a scarcity of work affects the principal occupation. Again, trade union standard rates of wages do not prevail in Germany to the same extent as in Great Britain. In consequence workpeople have greater liberty in accepting work at wages lower than those at which they have been previously employed, especially in bad times. A more speedy return to employment of the same kind, and a consequent reduction in the percentage of trade union members unemployed, results from this. The existence of a widespread and efficient organisation of municipal labour registries, in addition to the employers' registries, and those of the trade unions, is another influence tending to the quick restoration of the unemployed to the ranks of the more or less fully employed workers. A more important cause of difference between the German and British figures is found in the fact that the occupations represented in them are different, and especially that the former give comparatively slight influence to trades which are characterised by large fluctuations of employment, while the latter give such trades very considerable representation in the statistics. Thus, in the British figures a large representation is given to shipbuilding trades in which fluctuations of employment are especially violent. While this is not the only case in which the English figures are influenced in an important degree by the inclusion of industries liable to disturbances beyond the average, the German figures include hardly any important groups in which the unemployed rate is relatively high. So, too, the practice of meeting slack periods by working short time rather than by a reduction of staff, appears to be very considerably more general in Germany than in the United Kingdom.

It has been commonly assumed of late that the housing question has been more successfully dealt with in the capital of Germany than in the metropolis of the United Kingdom, but the investigation embodied in the present report hardly bears out this conclusion. Probably, says the report, no large city in the world bears externally an aspect more pleasing than Berlin. The city is modern save for

a diminishing area in the centre. Its buildings are almost of yesterday. Its newer streets are wide, well made and well kept, and avenues of trees of bright green, and open spaces, are common, while the municipal authorities, and the police, exercise a scrupulous care that the building regulations are not evaded. But Berlin seems to put her wealth into her front windows—the scarcity is kept in the background. In the census of 1900 there were in Berlin no fewer than 24,088 rented basement dwellings of all kinds in which 91,426 persons were housed. A large number of these dwellings—like the poorer quarters of West-end houses—were free from objection, but that cannot be said of the majority, and least of all of the 11,147 basements and back buildings in which 38,663 persons lived. In these basement dwellings were found low rooms, damp, decay, and absence of sufficient light. They were approached through dark corridors and passages along which it is necessary to grope one's way step by step, and it is no uncommon custom to keep a small lamp burning all day long. A fitting counterpart to the basement dwellings in the older parts of Berlin is found in the attics and higher stories of the same districts.

The impression produced by the mass of information conveyed in the report is that although the position of the German workman in the German towns has been considerably improved of late years, it remains much inferior to the general condition of the same class in England.

MEXICAN TIMBER.

It is estimated that the area under first-class woods in Mexico is from twenty to twenty-five million acres. The greatest quantities of pine and oak are found in the States of Chihuahua, Durango, Jalisco, Michoacan, and Guerrero, and the standing forests in these States compare favourably with similar timber in the United States and Canada, as regards quality. The best timber is still more or less remote from means of transport, but projected railway extensions, when completely carried out, will furnish facilities for the transport of one of the great resources of the Mexican Republic. According to a recent report of the Special Agent in Mexico of the United States Government, the white and red oaks of the country comprise six species, including the "roble" oak, a very superior grade, which is claimed to have no equal as regards finish. As evidence of the indestructible character of hard woods, it is stated that Mexican oak posts, after a period of thirty years standing in the ground, show a comparatively sound texture, and that railway ties employed in the higher altitudes remain good without treatment for from ten to twenty years. Mexican pine comprises six species, these being as follows: white, sugar, and bastard white; two fire, white and red, and a small percentage of yellow. There are also in Mexico some twenty-five varieties of hard woods not known to the lumber markets of the world, some of which, it is said, might be easily classed with other valuable hard woods. Mexican mahogany and Cedar are already well known in the New York market. The largest quantities of these fine timbers, or tropical hard woods, are found in the Gulf States, or, more definitely, on the Gulf of Mexico side of the Isthmus of Tehuantepec, in the States of Vera Cruz and Tabasco. Among the principal of these valuable woods may be mentioned the following:—The "zapote mamey," which resembles walnut in appearance, and is of a dark cinnamon colour, with about the same grain as mahogany, and capable of a very high polish; "zapote chico," of the same family as the "zapote mamey," is practically one of the most valuable woods grown in the tropics. The trees grow to a great size, the length of clear body being often fifty feet, and in sections of tropical Mexico are very plentiful. The sap, which is the "chicle" of commerce, is gathered in very much the same manner as the rubber sap. The business of producing this chicle has become a large and prosperous one in Mexico. The direct importations of chicle into the United States from Mexico for the three fiscal years 1904, 1905 and 1906, amounted in value to £94,000, £93,000, and £83,000, while the additional and indirect American imports of Mexican chicle gum, *viâ* Canada, for the three years in question were valued at £140,000, £150,000 and £180,000. The total exports of chicle from Mexico, in metric tons, the value not being stated, for the same years, were 1,850, 1,855, and 2,182, all of which practically went to the United States. The wood of this zapote tree is of a clear deep reddish brown colour, very hard, but easily worked until thoroughly seasoned, when only the finest edged tools have any effect on its surface. The fibre is of such density that the wood sinks rapidly in water. Zapote door frames in the historic ruins of the tropics of Mexico are almost as perfect to-day as when placed in position. The wood is susceptible of a beautiful finish and is valuable for furniture. From various tests in connection with railway and port construction it has been found that the chico zapote is of greater endurance than oak. "Zapotillo colorado" is another of the same family. This tree is often three feet in diameter and usually yields fifty feet of trunk without knots. The grain is very close, light in colour, and takes a fine polish. "Zapotillo blanco" is a beautiful white wood with yellowish tinge of even colour and much sought after for inside house finishing. The "palo maria," with a trunk from fifty to one hundred feet long and clear of knots, closely resembles mahogany in colour, grain and weight. One of the best known woods in Mexico is red cedar. This wood, even in colour and of fine grain, is largely used for lead pencils and cigar boxes. One of the most promising of the undeveloped Mexican woods is the "grandilla," a kind of rosewood, in appearance equal to mahogany, of a rich reddish brown colour with darker line markings. A

beautiful wood and one curiously marked is the "galeado." The colour is yellow with heavy irregular markings of the seal brown, close grained and very heavy. "Maccaya," much like hickory and used by the Indians for wagon work, "coralillo," "guagage," "huisch," "jicoco," corkwood, of which there is a large amount, lignum-vitæ, and others of value might be mentioned. Although vast stores of information regarding timber resources in many different countries have been accumulated it would seem, according to those intimate with the timber resources of the Mexican Republic, that the great wealth contained in its forests is practically unknown to the timber world. As before stated the railways are just beginning to open up the country in some of the timber regions. Lumber companies are erecting new and enlarged mill, and the lumber industry of the country, which is only in its infancy, is certain to have a tremendous growth with the advent of transport facilities.

JAPANESE AGRICULTURE.

Agriculture, being the occupation of more than sixty per cent. of the entire population of Japan, is indeed the greatest of all Japanese industies, but in the application of scientific principles to agriculture, and in the proportion of land under cultivation, Japan is far behind the progressive nations of Europe, and there is still ample room for improvement and development. The carrying out of the adjustment of land under cultivation is said to be of the utmost importance as a preliminary step towards agricultural reform. It is considered most necessary at the present moment to enlarge the small and irregular lots into which arable land is divided, to rearrange and reconstruct roads built for agricultural purposes, and waterways; to put to profitable uses unproductive pieces of land which now lie waste among cultivated fields; to improve land by facilitating irrigation and by other means, and to promote the use of machinery in agricultural pursuits. In 1900 the Government issued the law for the adjustment of cultivated lands, by which many special favours were granted, and gave encouragement to co-operative enterprise by the agricultural class. Although it is not long since the law was put in operation, it has already borne considerable fruit. Further, for the maintenance and improvement of the utilisation of streams, and the adoption of preventive measures against damages by floods, the establishment of stream-utilisation associations has been recognised by the Government. With the object of facilitating the supply of capital for agricultural purposes, the Government, according to a report of the Japanese Ministry of Finance, specially established the Hypothec Bank of Japan, the Agricultural and Industrial Banks, and the Hokkaido Colonial Bank. Moreover, in 1900, the Industrial Associations Law was issued, by which encouragement was given to the formation of credit, purchase, sale, and co-operative societies, and concentrated small capitals by methods of self-help, with the object of applying them for agricultural purposes. These associations are now making rapid progress. For the purposes of agricultural experiments, the Government established a State experimental farm in Tokio, and branches thereof in Kyushu, Chugoku (Middle Provinces), and Tohoku (North - Eastern Provinces), with the object of carrying on investigations relative to seeds, diseases and insect pests, agricultural instruments, stock breeding, and the manufacture of agricultural products, for experiments on the selection and supply of seeds and seedlings, and to consider matters necessary for the increased production and improvement of agricultural products. The establishment of prefectural experimental farms has been encouraged by means of grants in aid, so that these farms are now to be found in most of the prefectures. Moreover, agricultural experiments are carried on not only in the horticultural experiment ground attached to the State experimental farm in the Shizuoka prefecture, but also in many of the local experimental farms. With the object of effecting improvements in sericulture, one of the most important industries of Japan, the Government established two State sericultural training institutes, where, in addition to the training of experts in silkworm rearing and silk-spinning experiments, experiments are made in connection with these two subjects. Local corporations have also opened sericultural schools or training institutes, and are engaged in making improvements in sericulture, with the result that silk is daily increasing in output and improving in quality. Again, in 1896, the Government established a silk-conditioning house in Yokohama, where strict examination takes place, with a view to giving a sense of security to traders in Japanese raw silk. Further, at the State experiment farms, experiments are conducted in connection with the rearing of tea plants, methods of tea manufacture, and economy in the tea industry, and they have borne fruit in abundance. Especially is this the case with the study of tea-manufacturing machinery, which has resulted in the reduction of manual labour, diminution in the cost of production, and improvement in quality. For the purpose of stimulating local bodies to improvement in agriculture in their own districts, and also of gathering the full fruits of its agricultural policy, the Government encouraged the establishment of agricultural societies. These societies, which are formed in accordance with the provisions of the Agricultural Societies' Law, are of three classes, namely, those organised by the Hokkaido Government and prefectures, by districts, and by cities, towns, and villages. The last named, the lowest of the three, are composed of persons engaged in agriculture, while the other two are formed by societies of the class next below. Agricultural societies are established as judicial bodies throughout the country. With a view to the prevention and removal of

diseases and noxious insects from agricultural products, careful investigations were conducted at the State experimental farm, and other similar institutions, and the results were embodied in the law for the removal and prevention of diseases and noxious insects, which was strictly enforced among the agricultural classes. Again, to prevent the spreading of silkworms' diseases, the Government passed the Silkworms' Eggs Examination Law, and to prevent the spread of febrine, further issued the Silkworms' Diseases Prevention Law, and strictly carried out the examination of silkworms' eggs and disinfection against silkworms' diseases. The Government, moreover, issued the Cattle Diseases Prevention Law to provide against the outbreak of cattle diseases. With respect to stock breeding, the Government has given the greatest attention to the improvement of horses and cattle. The State bull pasture was especially established for the supply of bulls of good breed. Government officials are annually sent to Europe and America for the purchase of bulls, those of good quality being imported, bred, and supplied to private cattle owners. Stallions also are imported and bred in the same manner as bulls. There are at present two State stallion pastures, from which stallions, born and bred therein, are distributed among ten horse breeding stations situated in important localities, and mated with privately owned mares. The Government specially lends bulls and stallions to private applicants, for the purpose of improving horses and cattle, and in 1906 increased the number of bull pastures. In the same year a special office, called the Stud Administration Bureau, was established to take charge of the breeding, improvement, and general management of horses. Moreover, horse racing associations have of late been organised in various places, and the matter has greatly aroused the interest of the public. Public breeding establishments are also making great efforts for the improvement and breeding of horses and cattle. Several large pastures, under the management of the Imperial Household, also produce every year many horses and cattle of good quality, and these have had a highly beneficial influence on the improvement of live stock.

THE INDIAN RAILWAYS.

The Administration Report of the Indian Railway Board has just been issued, and from it it appears that during 1907, 924 miles of new lines were opened to traffic, bringing the total mileage open up to 30,010 miles, on the following gauges:—

Miles	15,821	on standard	5 ft. 6 in.	gauge.
,,	12,613	,, metre	3 ft. $3\frac{3}{8}$ in.	,,
,,	1,234	,, special	2 ft. 6 in.	,,
,,	342	,, ,,	2 ft. 0 in.	,,

The actual capital outlay (excluding premiums for the purchase of companies' lines) from the commencement, on all open and partly open lines amounted, at the close of 1907, to 39,843 lakhs, and that on lines wholly under construction to $242\frac{1}{3}$ lakhs of rupees. In addition, 84 lakhs were incurred on miscellaneous items (English stores, &c.) connected with railways. The total outlay amounted to $40,169\frac{1}{2}$ lakhs.

The net earnings yielded a return on the capital outlay, on open and partly open lines, of 5·77 per cent. as compared with 5·85 in 1906.

Passenger traffic continues to develop, and a larger number of pilgrims, native marriage parties, visitors to fairs, &c., was carried. The visit of the Amir of Afghanistan to India and the Calcutta Industrial Exhibition all helped traffic, and the scarcity in the United Provinces and Behar also led to the migration of labourers in search of employment. The total number of third-class passengers carried rose by over 31,000,000, and the earnings therefrom by over 123 lakhs of rupees. Of the total increase in the passenger receipts, 21 per cent. was earned by the North-Western State Railway. The average rate charged for passengers of all classes was 2·44 pies, or rather less than a farthing per mile, and the average distance travelled was about 36 miles. There have been no material fluctuations in these figures since 1884.

In regard to goods traffic, there was an improvement over the figures of the previous year of 3·23 million tons, and $164\frac{1}{2}$ lakhs of rupees. Of this increase the North-Western State Railway earned 39 per cent., the Great Indian Peninsula Railway 19 per cent., while the remainder was contributed principally by the Oudh and Rohilkhand State, Bengal-Nagpur, Bengal and North-Western, and Southern Mahratta railways. Grain and pulse, raw and manufactured cotton, coal, oil-seeds, sugar, and jute, all showed increases, the higher figures in the first two items being due to the scarcity in the United Provinces and the larger bookings of wheat for shipment. Oil-seeds and cotton, too, showed much heavier exports, and these movements were naturally reflected in the railway returns.

As to the coal trade, the total output from the collieries in India and Burma amounted to 11·15 million tons, as against 9·78 million tons in 1906. The imports from the United Kingdom rose by nearly 28,000 tons, and those from other countries by 47,260 tons.

The additional mileage worked, the larger traffic handled, and the increase in the train mileage run, necessitated a corresponding increase in the working expenses. Large sums were also expended by the principal railways in renewing their permanent way and rolling stock and in strengthening bridges, and, as a consequence, the railways were worked during 1907 at 51·38 per cent. of gross earnings, against 49·88 per cent. in the previous year.

The financial result of the working of the State and guaranteed railways for 1907 was a net gain to the State of 382 lakhs of rupees, after meeting in addition to the expenses of working, all charges for interest on capital raised by companies, and also the annuity

payments for railways purchased by the State, including both interest and the portion that represents redemption of capital. This is the eighth year in succession in which there has been a surplus.

Several small strikes of employees occurred during 1906 and 1907 on certain lines. On the North-Western State and the Bengal and North-Western Railways, the discontent was removed without inconvenience to the public, but that on the Eastern Bengal State Railway culminated in an extensive strike on the part of native drivers and firemen, and caused a temporary dislocation of goods traffic. On the East Indian Railway the European and Eurasian drivers of the Howrah-Jhaja district, after submitting a lengthy list of grievances, struck work in November, and were joined to a large extent by the traffic staff, the strike extending to other districts and involving a large portion of the line. This strike was the most serious in the history of the Indian railways, and for a time completely dislocated traffic generally and the trade of Calcutta in particular. It was only terminated by the appointment by the Government of India of a special Board of Conciliation, based on the lines of the Boards recently introduced in England, and through this agency an arrangement was eventually effected in regard to higher pay or mileage allowance, extra pay for working overtime and on holidays, and improved leave rules.

RAILWAY ELECTRIFICATION.

Electric traction on railways seems to be receiving more attention from railway managers generally abroad than in this country. Even here, however, progress is being made. The single-phase alternating current system is already at work on the branch lines of the Midland Railway Company between Lancaster and Heysham, and the electrification of the South London line of the London, Brighton and South Coast Railway will soon be complete. In the United States the New York Central, and the New York, Newhaven, and Hartford railroad systems, both local and main lines, entering New York Terminal station are now operated by electricity. In Sweden the Government have been carrying on experiments since 1905 on their experimental line in the neighbourhood of Stockholm, and the results appear to have been so satisfactory that the Swedish Government has decided to electrify an extensive section of the railways. The Italian, the Swiss, and Austrian Governments are considering the advisability of adopting electric traction of part of their railway systems, and the Bavarian Ministry for Railways has been making similar enquiry. The explanation of the general activity given by the Bavarian Government in an interesting report just issued is that it is only since 1902, when the single-phase alternating current motor had become a practical machine, that owing to its simplicity and ease of transmitting power over long distances it was possible for the railway authorities to consider the matter. Mr. Philip Dawson, who is supervising the completion of the Brighton and South Coast Railway electrification, is of opinion that the "conclusion reached on the Continent to electrify long distance lines does not unnecessarily prove that such a decision will be justified in this country. Indeed it is probable that for a considerable time to come electrification will only be seriously considered in this country in connection with the operation of suburban lines over which there is an intense traffic." Mr. Dawson thinks it may be possible, and even probable, that experience with short distance electrically operated local lines may eventually cause the electrification of some long-distanced lines, and consequently, whatever system is adopted for short distance traffic, it must be such as can easily be extended to any distance that railways may require.

In a paper recently read before the American Society of Civil Engineers, Mr. Wilgus, late principal official of the New York Central Railroad, emphasises many of the advantages of the electric locomotives. They mean smaller costs of repairs and fixed charges of electric as compared with steam locomotives; considerable saving in time due to the much smaller amount required for repairs and inspection, and considerable additional facilities for handling traffic, seeing that an electric locomotive is always ready for instant action, and no time is required, as in steam, for firing and getting up steam, and there is no waste in firing when standing by. Mr. Dawson adds another advantage which the entire haulage of trains by electricity in the suburbs would offer. The number of bridges under which suburban railways travel is very considerable, as well as the number of platform roofs at stations, and the absence of steam locomotives would materially lengthen the life of all structural steel at those heights, which at the present moment are being seriously damaged by the steam and exhaust gases of existing locomotives.

THE "NATIONAL JUNIOR REPUBLIC."

On a farm of 146 acres, about midway between Baltimore and Washington, on the Baltimore and Ohio Railroad, and two miles from Annapolis Junction station, is situated the National Junior Republic, the school for the education of delinquent boys. This school was established in 1899 on the system laid down by Mr. H. R. George, of New York, and appears to have been attended with much success. The result of the methods used would seem to be that the boy gains an understanding of the law and respect for it. Self-respect is developed and willingness to obey is created. In his report on the trade of the district of Baltimore (No. 3982 Annual Series) Mr. Consul Fraser gives some interesting particulars respecting this rather strangely named school. A boy when he enters it must be 13 and not over 17 years

old and must be of the class called "incorrigible." He must be medically certified sound in mind and body, and when received into the Republic must be released to the institution by a Baltimore or Washington magistrate should he be committed, or by the boy's parents or guardians during his minority. Payments as agreed upon must also be made monthly. Exceptions to these conditions are only made in exceptionally deserving cases. The institution is maintained—except by the income derived from the product of the farm, the small payments made by the parents of some of the boys, and an annual appropriation from the State of Maryland—by the voluntary contributions of the people of Baltimore and Washington. The cost of maintenance per annum exceeds the receipts by nearly £1,600, which has to be met by subscription. There are at present 48 boys at the institute, and the staff consists of a superintendent, general purpose man, farmer and assistant manual training teacher, school teacher and assistant, house mother, seamstress, housekeeper and cook.

THE COTTON SPINNING TRADE.

Mr. J. R. McColl, who was the President of the International Cotton Congress held recently at Atlanta, has just left this country for the United States, but, before leaving he was interviewed in Manchester on the condition of the cotton trade. Mr. McColl told his interviewer that he had visited some of the important industrial centres in France, Germany, and this country, and everywhere he finds "machinery stopped, short time, unprofitable prices, and absence of demand for goods." Mr. McColl approves the action of the Paris Congress in endorsing the buying of cotton on net weight, the object being to further the movement for a decent American bale similar to the Egyptian bale. Since spinners and growers have come into closer relations, active efforts are being made throughout the Southern States to induce new methods of compressing and gathering cotton. New types of compressers are being invented, and before many years have passed the American bales may be expected to be in keeping with the business enterprise and energy of the American nation. Mr. McColl thinks it was unfortunate that an experimental plantation scheme was abandoned by the English spinners. He says that no opposition need be feared from the leaders of the Growing Associations, who recognise the important advantages that would accrue from looking more closely to the producers and consumers in a common effort to increase the volume and efficiency of cotton-growing in America, for it is pretty generally admitted that Europe has for many years to be dependent on the Southern States for raw material. The simple investment necessary to carry on experimental plantation work would be as nothing compared to the benefits that might be derived from it.

HOME INDUSTRIES.

The Hop Report.—The report of the Select Committee appointed to inquire into the past and present condition of the hop industry contains much useful information as to the industry, but it cannot be said to be very new. It is admitted on all hands that the hop industry is in a critical condition, but the Committee does not see its way to do more than urge the importance of detailed and recent information as to what is going on in other countries in regard to the industry. It is essential for a prudent grower to take a world-wide view of the movements which from time to time occur in the industry with which he is concerned. This information is supplied by the Department of Agriculture of the United States, which publishes bulletins for the information of hop growers not only in regard to statistics of the world's trade, but also in regard to most approved and up-to-date methods of growing and curing hops. The Committee think that great advantage would accrue to hop farmers in this country if similarly informed and authenticated bulletins dealing with improved modes of cultivation and the latest statistics of the foreign trade and industry were placed at their service by the Board of Agriculture. There can be little doubt that the introduction of cold storage has done as much, if not more, than anything to bring the hop industry of the kingdom to its present pass. In the old days, if the hop grower had a short crop he might rely with confidence upon prices compensating him to a large extent. Indeed, sometimes a short crop was more profitable to him than a large one; since the reduction in working costs and the rise in price more than compensated for reduced output. But a great change has been effected in the hop trade by the introduction, during the last ten or fifteen years, of the system of cold storage. The advent of cold storage, as the Committee points out, has affected an adjustment between years of plethora and years of scarcity with the resultant effect upon prices. Hops stored in the ordinary way deteriorate by reason of the essential oil resinising, by oxidation of the preservative resins, and by reduction in the amount of tannin. By means of cold storage these changes are very materially retarded, for hops so treated, after even four or five years show very little reduction in their brewing qualities.

The Whisky Report.—The Royal Commission on Whisky has published an interim report in which they find that any potable spirit distilled by any processes either from malt or from malt and unmalted barley or other cereals, is entitled to the description of "whisky." In their opinion "no restrictions should be placed upon the processes of, or the apparatus used in, the distillation of any spirit to which the term 'whisky' may be applied as a trade description." They also find "that the term 'whisky' having been recognised in the past as applicable to a potable spirit manufactured from (1) malt, or (2) malt and unmalted barley, or other cereals, the application

of the term 'whisky' should not be denied to the product manufactured from such materials." These findings are irreconcilable with the contention of the Islington Borough Council that various liquors hitherto sold and invariably known as whisky are not whisky, and that any one selling them by that designation is guilty of an offence under the Sale of Food and Drugs Act, a contention supported by Mr. Fordham, who convicted persons sued by the Council upon the strength of a definition of whisky which, in the opinion of the Commission, is not supported by authority. The Commission postpone stating in full the grounds upon which they have arrived at their conclusions until their final report is issued, and they reserve for further consideration the questions of the advisability or otherwise of attaching special significance to particular designations such as "Scotch whisky," "Irish whisky," "grain whisky," and "malt whisky;" of placing restrictions upon the use of such designations as trade descriptions, and of requiring such designations to be used in connection with the sale of whisky. Even assuming that workable definitions of these variously-named whiskies can be found, it remains to be seen whether restrictions can be usefully placed upon their use as trade descriptions, or conversely such specific descriptions be used in connection with the sale of whisky. It must be a matter of great difficulty to define these varieties in a manner suited to legal agreement. The public chiefly desire blends, and the blender cares little what is the origin of any liquor that serves his purpose as a component. The blend usually contains both malt whisky and grain whisky, and these may be made anywhere, and in a pot still or a patent still. The findings of the Commission must be considered a victory from the patent still point of view.

Washerwomen and the Compensation Act.—The question whether a washerwoman is a "workman" within the meaning of the Compensation Act was submitted to the Court of Appeal on Friday last, and the Court affirmed the decision of the County-court judge, that the woman's employment was "periodical" and not "casual" employment, she being in the habit of working for the defendant, and going to his house for this purpose on alternate Tuesdays. One day whilst at the defendant's house, and in the course of her employment, she pricked her thumb with a pin whilst washing the cellar steps, blood-poisoning followed, and she lost the use of her hand. The effect of the Compensation Act upon this class of "workman" illustrates the way in which Parliament may injure those it is its desire to serve, and which it thinks it is serving in passing a particular Act. Since the passing of the Compensation Act large numbers of charwomen have lost their work or found it more difficult to get. Of course many charwomen must be employed come what may, but in the suburbs, at any rate, in London, their employment is gone, or seriously affected, by the unwillingness of employers to make themselves liable for accidents to charwomen, or to pay to an insurance company the small amount that would shift the risk upon other shoulders. And so the charwoman often finds herself in a worse position than before the passing of the Act.

The Cotton Trade Outlook.—It has been pointed out from time to time in these Notes that the number of new mills erected must inevitably bring about, sooner or later, something like a crisis in the cotton trade, and this now seems to be within sight. In his latest report Mr. W. Mullins, the Secretary of the Cardroom Workers' Amalgamation, speaks of "the unreasonable policy of mill-building speculators and position-seekers" who have brought about the present state of over-production, necessitating organised short time working throughout the industry. The Employers' Federation have recommended the trade to seek a further reduction of 5 per cent. in wages. The operatives' representatives have not yet stated their views as to this proposal, and it may be feared that it will cause trouble. If the recommendations, now made by the employers, are carried out, it is calculated that about 55,000,000 spindles will be affected. When the last 5 per cent. was given, the President of the Federation expressed the hope that when bad trade caused the employers to ask for a reduction, the operatives would be as generous to the employers, as the latter had been to them. Whether they will be is another matter. It is now fifteen years since the operatives have submitted to a reduction in wages. In 1893, sevenpence in the pound was taken off their wages, but it was returned to them in March, 1899. The situation has raised the question whether these matters cannot be usefully jointly discussed by the employers and the workpeople. Clause II. of the Brooklands Agreement provides for such a Conference. It runs:—"The above committee shall meet whenever the Secretary of either Federation shall be of opinion that questions affecting the general interest of the cotton trade should be discussed."

Losses by Fire.—Most cotton mills are now protected with automatic sprinklers, and the damage caused by fire is often small as compared with that occasioned by water. The majority of fires originate in the spinning frames in the upper storeys of the mills, the carding machines being placed on the ground floor, so that the cards are often deluged with water distributed by the automatic sprinklers or other fire appliances. Even where the mills are supposed to be fireproof much water has been known to find its way through the concrete floorings into the lower rooms. The card clothing is very susceptible to injury by water owing to the difficulty of removing the effects of damp from the wire teeth. Considerable salvage can be effected from prompt attention to most of the machinery but the cards are usually abandoned as a total loss, there being no method of removing the effects of damp from the wire teeth.

If only some inventor could devise such a method the fire loss in cotton and woollen spinning mills would be considerably minimised.

GENERAL NOTES.

SISAL GRASS.—The State of Yucatan in the Republic of Mexico is the source of the sisal fibre that comes to New Orleans. It is grown in no other part of Mexico. Sisal grass is a substitute for hemp, and it is one of the chief materials used in the United States for making rope and other cordage. The plant (*Agave sisalensis*) grows from shoots in poor soil where other cultivation is impracticable, and comes to maturity in five years. Replanting is necessary every fifteen years. The leaf at the proper time for picking droops and has then reached its greatest value, as the fibre is then at its maximum strength. It is an article of trade largely monopolised by New Orleans, from which port it is forwarded to Chicago and other northern and western manufacturing centres. Sisal grass is on the free list and pays no duty in the United States.

GERMAN TOYS.—Last year reference was made in these Notes to the immense number of German toys imported into the United Kingdom from Germany, and Baron Bernhard von Tauchnitz, reporting on the trade of the Consular District of Leipsic (Annual Series No. 4008), shows that the German export continues to grow. Children's toys took the fourth place in 1907 among special articles in the export trade between this country and Germany. The other most important exports from the Leipsic district were sugar, close unbordered half-silk textiles, woollen stuffs, &c., and raw puddled iron mill bars and ingots, toys showing an export value of 21,050,000 marks. Australia still remains the best buyer of German toys among British colonies, taking goods to the value of 1,662,000 marks in 1906, a figure which will probably have been maintained, the Consul-General says, for 1907. The import into British India has again increased, and the demand from Canada continues to increase.

THE COTTON INDUSTRY IN ITALY. — Last year was a good one for the cotton industry in Italy, where this industry has developed enormously. An export trade in yarn and cloth is now well established with the East and South America, though this may to some extent be due to the production exceeding the demand in Italy itself. There is still, reports Mr. Consul-General Keene (No. 4020, Annual Series), a market for the better class of printed cotton goods of foreign manufacture. Mr. Keene is of opinion that British trade might be largely developed in Piedmont if the same conditions for payment were granted as are allowed by French and German exporters. There would also seem to be an opening for cotton canvas and jute tissues and embroideries. Other British goods that sell well are machinery, paper, stationery, lubricating oils, draperies, cutlery, muslins, cheap carpets, belting, and house linen.

BRITISH TRADE WITH NICE.—Commenting upon the trade and commerce of Nice for last year (No. 4053, Annual Series), Mr. Consul McMillan considers there is a promising opening in Nice, and in other towns of the Alpes Maritimes, for British chemists who charge what are known as "store prices." Also for dealers in British cloths and tweeds, which are so much appreciated in France. There is also an opening for enterprising traders with capital enough to start establishments of the "universal provider" sort. The Consul is of opinion, too, that there is a promising opening in Nice for a boys' school under a British headmaster. There was a school of this kind there which flourished for many years until it came to an end owing to the increasing infirmities of its director, since deceased. The trade in motor-cars is increasing, and if British makers would take part in prize competitions, and would advertise more fully, they ought, says the Consul, to come in for a share of this trade. Similar remarks are applicable to trade in bicycles. In the case of motor-cars the customers to be got are not numerous, but they are rich, and in the case of bicycles the ordinary customers are not rich but they are numerous.

THE CITRUS INDUSTRY.—During 1907 much attention was given by citrus-producing British colonies to the by-products of the citrus, and especially to the manufacture of citrate of lime. In the West Indies, where the question of the utilisation of inferior fruit unsuitable for the table has been occupying the attention of the planters, and citrate of lime has been produced, the manufacturers sought for information regarding the methods adopted in Sicily for the production of citrate of lime. There can be little question, writes Mr. Consul Churchill in his report on the trade and commerce of Sicily just issued (No. 4025, Annual Series) that the means used in Sicily at the present time for making citrate of lime are primitive and wasteful. Having such plant in use the manufacturers are little inclined to cast it aside in favour of more expensive machinery. The competition in the trade is becoming keener and the margin of profits diminishes. During the summer of 1907 the "Citrica Sicula" of Palermo, which had been originally founded in order to support the Restuccia process of making citrate of lime, combined with the Sociéta Derivati of Aci-Reale in order to try and do away with the middleman commission agent and thus increase their margin of profits in the manufacture of by-products to the planter and the manufacturer. Last year Palermo exported 127,137 tons of lemons and oranges, one-fifth of which was absorbed by the United Kingdom, which also took the bulk of the trade in lemons in brine.

Journal of the Royal Society of Arts

No. 2,906. VOL. LVI.

FRIDAY, JULY 31, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

FUEL AND ITS FUTURE.

By Professor Vivian B. Lewes.

Lecture III.—Delivered March 23rd.

We have seen that for the generation of heat in most manufacturing processes an economy of at least 25 per cent. could be attained by gasification of the coal before use. Although an initial loss of 20 per cent. of the calories is entailed by the process of converting it into poor fuel gas, the ease of application, reduced volume of air needed to yield complete combustion, regeneration, and other economies of the same kind, bring up the amount of the thermal value of the fuel utilised from 10 per cent. to between 40 and 50 per cent. The absence of smoke from the factory shafts would be a big stride forward in the work of cleansing the atmosphere, an aim which every thinking person has in view at the present time. Indeed, the whole question of fuel economy is so closely allied to the problem of smoke prevention that it is impossible to consider the one without alluding to the other, and if only sufficiently drastic steps were taken to enforce rational methods of domestic heating, both economy of fuel and cleansing the atmosphere would follow.

In the south of England at any rate the domestic grate using bituminous coal is the principal cause of the smoke cloud which, hanging over the big towns, cuts off the direct rays of the sun, ruins health, shortens life, kills vegetation, and begrimes and finally helps to destroy our public buildings. Further north in the manufacturing districts the factory shafts, in spite of restrictive legislation and mechanical improvements in stoking, do even more towards polluting the atmosphere.

Many estimates of the relative amount of pollution due to manufacturing works and domestic fuel have been made, but as the question of what is the ratio of smoke production from the various sources that pollute the air varies enormously with the locality, no very satisfactory conclusion having been arrived at.

If you take London, Dr. Shaw's estimate that 70 per cent. of the smoke is domestic would probably be about correct, but if you collected your statistics in Sheffield or Birmingham, the figures would most likely be reversed. There is one thing certain, however, and that is that domestic smoke is produced throughout the whole length and breadth of the land, whilst the factory shaft concentrates its attention on the more limited area of the manufacturing districts.

Although the smoke from the domestic chimney has been execrated for the part it has played in the pollution of the atmosphere from the earliest years of the fourteenth century down to the present day, it is surprising how crude the ideas are that exist as to its composition and the method of its production. In the open fire the radiant heat given by the incandescent fuel is the heating agent, and although undoubtedly wasteful in fuel, owing to the largest proportion of the heat escaping with the products of complete and incomplete combustion up the chimney, still is so far more hygienic and more comfortable than any other method of heating that one would be sorry to see its place taken by any other form of heat production, in spite of the economic advantages of central heating systems, or slow combustion stoves.

With the ordinary grate, using bituminous coal, the production of smoke means waste of fuel, but great as this is in the aggregate, it is small as compared with the other losses due to actions taking place in the fire itself, and loss of heat escaping up the chimney. When bituminous coal is fed on to the burning fire, the action which takes place is practically the

same as that occurring during the distillation of coal, and it is during this period that a very large proportion of the heat latent in the coal is lost, owing to the amount taken up in decomposing the coal and converting the volatile portions into vapours and gases. During this period you have the coal, heated by the fire from below and comparatively cool above, distilling off tar vapours, coal gas and steam, in about the same proportions as they are emitted during the destructive distillation in the gas works. In the early stages, the surface of the fuel being too cool to lead to their ignition, they escape as vapours up the chimney, mingled with anything from eight to thirty thousand cubic feet of air per hour, according to the draught in the chimney. In an ordinary flue an analysis of the escaping products would give an approximation to the following:—

Carbon dioxide	0·70
Methane	0·36
Hydrogen	0·29
Carbon monoxide	0·01
Oxygen	19·85
Nitrogen	79·79

During this period of smoke production no soot is formed, and the physical properties of the cloud of vapour form an interesting study, as it explains one of the secrets of the lasting power of smoke and the way in which it acts. A puff of such smoke blown through a small glass cell illuminated from below by oxy-hydrogen or arc light, and examined under a low-power microscope, reveals the fact that this form of smoke consists of excessively minute vesicles, which are in a marvellous condition of motion, and which will remain floating in the stream of air or gas until impact with a solid surface causes a bursting of the little liquid envelope, forming a microscopic drop of tar on the solid against which it has struck, and liberating the contained gases.

This period is the one in which the most serious waste takes place, as not only is the greatest amount of heat being rendered latent by the distillation out of the coal of these products, but you also have them escaping unburnt up the chimney. After a period, which varies in length according to the amount of coal which has been fed on to the fire, sufficient heat finds its way to the top of the fuel to ignite some of the escaping vapours, and the bright illuminating flame is then formed above the surface of the fire. This flame radiating a considerable amount of heat owing to the incandescent particles within it, the waste ceases to be as great as before, but a large amount of vapour will be noticed to be still escaping unburnt, owing to some of the hydrocarbons being so diluted by steam and the cold air sucked in over the surface of the fire as to stop their combustion.

If now the flames themselves be watched, it will be seen that they become red and lurid towards the top, and are emitting particles of carbon. It is during this period of combustion that soot is deposited in the chimney and appears in quantity in the smoke, which now consists of tar vapour, soot, water vapour, products of combustion, and excess of air, together with the residual nitrogen from that portion of the air which has been used in the combustion, and also particles of ash sucked up by the draught in the chimney.

As time passes on the fire burns clear, the amount of flame becoming extremely small and consisting chiefly of carbon monoxide, and practically smokeless combustion is attained. Until more coal is fed on no further pollution of the atmosphere takes place, whilst the clear fire radiating out the heat given by the combustion of the incandescent carbon is doing more heating work than at any other period.

In order to overcome the trouble of smoke whilst using solid fuel, many forms of grate have been suggested, the most successful of them being dependent upon the principle of feeding the fresh fuel to the bottom of the fire instead of to the top, so that as the tar, hydrocarbon vapours, and steam distil out from the coal, they have to pass through a mass of incandescent carbon above, which decomposes the complex tar vapours into simple hydrocarbons. These are then completely burnt up on reaching the fresh air supply at the top of the fuel.

The fact, however, that any special form of grate would require the removal of the old type and introduction of the new, has been sufficient to prevent any success in such directions, and what is really needed to make smoke prevention a practical possibility is the introduction of fuel which could in every way be treated like coal, which would be as easy to ignite, would burn with a cheerful flame, and would in reality commence its combustion just at that period when, in a fire, the smoke has ceased and the fire burnt clear.

I have always been strongly of opinion that

the only way in which the smoke problem could be solved was in stopping the direct combustion of bituminous coal in grates and furnaces, and employing the gas works of the country to convert it into gaseous and solid fuel, both of which would give us smokeless combustion, at the same time extracting in useful form those volatile products which, in the manufacture of gas, yield tar, but in the stove or furnace form smoke.

The domestic use of gas for heating purposes has advanced with great rapidity; and although its cost comes out considerably higher than that of coal, yet when used under proper conditions, it is practically not much more expensive, the economy in handling and cleanliness making up for most of its extra cost. In a very large number of households at the present time gas is employed for cooking, and for heating the bedrooms, whilst it is only in the sitting-rooms that solid fuel plays an important part. Coke, on the other hand, owing partly to prejudice and partly to the fact that it is difficult to ignite, and only burns freely when the stove happens to have a good chimney draught to aid it, has never proved a serious rival to coal, but during the past year the question of smokeless fuel has again come to the front. The idea of using low temperature carbonisation for the manufacture of coal-gas so as to improve the quality of the gas and other residuals obtained, offers a means by which a perfect domestic fuel can be made, which, igniting with greater ease than even coal, burns in the ordinary firegrate with a cheerful and smokeless flame, and emits more radiant heat in a more uniform manner than any alteration in the form of stove could effect with bituminous coal.

It is now twenty-two years since Mr. Lewis T. Wright read a paper before the Society of Chemical Industry under the title of "What shall we do with our tar?" In it he advocated its use as a fuel for heating the gas retorts, the object being to reduce the output, and so stem the slump in prices which had brought tar down from the position of the most paying of the residuals of coal distillation to so low a price that it was practically a waste product.

In the discussion that followed the paper Dr. Armstrong asked the pertinent questions —Was the gasmaker right in his present method of treating coal? Would it not be better to deal with it so as to produce a large proportion of residuals and a different class of coke? In the twenty-two years that have elapsed since these questions were asked, the gas managers of the country have not only ignored them, but have, with self-complacent egotism that brooked no interference, worked in the exactly opposite direction. Now that the Parliamentary standard of candle-power has been lowered over part of London, and the necessity of purifying the gas from sulphur compounds other than sulphuretted hydrogen has been removed in order to relieve the companies from the burden of enrichment and lime purification, the temperature of distillation in some cases is being pressed to the highest point that is possible without entailing stopped ascension pipes and naphthalene choked mains. The result is that in some districts the sulphur compounds in the gas, which increase with increase in the temperature of carbonisation, have reached a proportion that proves disastrous to inverted fittings, and as the inverted incandescent burner is undoubtedly the means by which gas will chiefly be burnt in the future, the sulphur question once again threatens to become an important one.

The reason which has led to this craze for high temperature distillation, is that it increases the volume of gas at the expense of hydrocarbons present in both gas and tar vapour, so that, instead of obtaining 10,000 cubic feet of gas per ton of coal carbonised at the old heats, it is possible to obtain over 11,000, but with an increase of hydrogen in the gas, and at the expense of loading the tar with particles of free carbon, to the general detriment of the pitch obtained from it.

Now that the pollution of the atmosphere of our big cities by smoke has become so bad as to rouse the smoke reformers once more to activity, and to lead to the demand that London, like New York, should be freed by State action from the curse of bituminons coal as a fuel, other thinkers, untrammelled by a life's training in the gas works, have seen that the road to economy of fuel, smoke abolition, and an improved gas supply lies in an exactly opposite direction to that which the gas manager has looked upon as the royal road to success.

Coke, the solid product of high temperature distillation, has never found favour with the middle and upper classes as a domestic fuel, owing to its being somewhat difficult to ignite and not burning freely, and its chief market has been for steam raising and other manufacturing purposes, very little finding its way

into the householder's grate. The result is that had not carburetted water-gas offered a convenient and economical way of using it on the gas works, many companies would have found great difficulty in keeping up the price during the years that coal was cheap.

Under these conditions Col. Scott-Moncrieff suggested many years ago the use of a half-coked coal as a fuel supply, and tried to make a commercial article by carbonising coal at the ordinary gas-retort temperature, drawing the charge when half the usual volume of gas had been distilled out from it. Two factors, however led to failure, the one being that the time was not ripe, and the second that the means by which he proposed to carry out his entirely admirable idea could never give a uniform fuel for reasons which I shall fully discuss a little later.

The idea, however, again came to the fore, and a perfectly independent worker found the secret of successfully making a fuel by the distillation of coal at a low temperature, which should ignite more easily than coal itself, should burn freely in an ordinary grate with a cheerful flame, and yet be absolutely smokeless.

The idea being taken up and vigorously pushed in the City resulted in the formation of a company, and the shock which the *amour propre* of the gas industry received at finding amateurs gravely proposing to show them how coal should be carbonised roused in them a feeling of rabid resentment, which was admirably reflected in the articles of the leading gas journals.

At the time of the exploitation of the process I very carefully went into it and was deeply impressed with the possibilities it presented. Since then I have had the opportunity of seeing and testing the progress that has been made, and I feel that in the interest of the gas ndustry it would be well if gas managers would lay aside for the time being their feeling against the process, and gravely consider the facts I desire to place before them.

When an ordinary gas coal is subjected to destructive distillation, the volume of gas, its heating and illuminating value, and also the quantity and quality of the tar undergo great changes, according to the temperature at which the distillation is carried out. The following Table shows the average results that are obtained with a good sample of gas coal. The term "average results" is used, as variations in the coal employed introduced alterations in the results, although they will all follow similar lines.

YIELD OF GAS AND TAR PER TON OF COAL CARBONISED.

Temperature of distillation.		Volume of gas.	Tar.	Specific gravity of tar.
°C	°F	cubic feet.	gallons.	
900	1652	11,000	9	1·200
800	1472	10,000	12	1·170
700	1292	9,000	15	1·140
600	1112	7,750	18	1·115
500	932	6,400	21	1·087
400	752	5,000	23	1·060

A glance at this Table at once makes clear the position taken by the average gas manager, who argues that his duty is to make gas, and who looks upon residuals as more or less worrying factors which however redeem their position by helping to pay the coal bill. As high temperatures yield most of the product he desires, he strives to get to the highest heat compatible with the life of his plant and the avoidance of stopped ascension pipes, and in concentrating his attention on the volume of his gas he loses sight of the damage he is doing to his residuals.

Tar, as made in the manufacture of gas, that is at temperatures between 800 and 900°C, is a product which bears very little resemblance save in colour to the liquid products that first distil from the coal, being largely built up of the products of secondary reactions taking place at the high temperature of the retort, such actions being responsible for the formation of the naphthalene and many of the aromatic hydrocarbons. If the temperature falls owing to bad furnace arrangements to between 600 and 800° C, then these secondary actions are checked, and members of the saturated and naphthene series of hydrocarbons begin to make their appearance. These so complicate the separation of the benzene and other valuable constituents of the tar that the distiller fights shy of them, and the gas manager gets the idea that low temperatures ruin his chief liquid residual. If, however, the temperature be boldly dropped to between 400° and 500° C.—a temperature no one ever dreamt of employing for the carbonisation of coal until the present process was introduced—the character of the tar entirely alters. The aromatic series diminish to a point at which they are not worth recovering, and paraffins and certain unsaturated hydrocarbons make

their appearance in such quantity that the first distillate gives a valuable motor spirit, yielding 12·5 per cent. better results than "petrol." For this there is an ever-increasing market at better prices than if benzol had been the product. In the same way the middle oils are so altered in character as to be unrecognisable, and, being free from napthalene, give valuable by-products, or, as crude distillates, yield excellent fuel and enriching oils. The low temperature of distillation also has told its tale in the pitch, and as this contains no free carbon, it forms an ideal insulator, which in these days of electric traction becomes a valuable asset.

The gas also alters in composition with the falling temperature, and a glance at the following analyses shows at once that the increase of volume yielded by the high temperature has been at the expense of the degradation of the hydrocarbons, which, decomposed by the heat, have yielded hydrogen to swell the volume of the gas and free carbon to ruin the pitch.

Effect of Temperature of Carbonisation on the Percentage Proportions of the Chief Constituents of the Gas.

Temperature.	400° C.	500° C.	600° C.	700° C.	800° C.	900° C.
Hydrogen	21·2	28·3	33·8	41·6	48·2	54·5
Saturated hydrocarbons	60·1	56·2	50·7	45·0	39·1	34·2
Unsaturated hydrocarbons	6·3	5·8	5·0	4·4	3·8	3·5

So, although only 5,000 cubic feet of gas are obtained from the coal, it is over 20 candle-power, and has a calorific value of 750 British thermal units per cubic foot, whilst the low temperature of carbonisation has reduced the sulphur compounds other than sulphuretted hydrogen to a point that would satisfy the most ardent stickler for purity.

The temperature is too low to convert the full proportion of the nitrogen into ammonia, with the result that it is only two-thirds of the amount yielded per ton of coal that is obtained at the high temperature, whilst the coke produced is so different in character as to be a revelation to those who use it for the first time. Analyses of the coke made show that the easy ignition and flaming but smokeless combustion of the low temperature product are due to the high proportion of volatile matter still remaining in it.

Enough has been said to show that lowering the temperature of carbonisation to a degree never before attempted—if done in the right way—entirely revolutionises the products formed. New markets are created for the by-products, which become of far greater value than the present coke and tar, whilst an illuminating gas of ideal composition and purity is produced.

The gas industry, however, cares but little for these points, the fatal fact that only 5,000 cubic feet per ton instead of over double that quantity of gas is made, needs some stronger argument than the desire of the public for clear skies and a better quality gas supply to break down their opposition, but I think a little consideration of the financial side of the question must convince anyone with any knowledge of the subject that not only is every factor of quality in favour of low temperature carbonisation, but that the manufacturer's balance-sheet is the most overwhelming argument that can be produced in its favour.

The fact that a temperature is employed so low as to be invisible in bright daylight reduces the wear and tear of plant and brick work to a small fraction of that entailed with high temperatures; the plant itself costs a quarter of the price of the ordinary retort benches for a given make of gas and occupies a far less area, whilst labour is reduced to a minimum by the feeding, discharging and moving of the material being all mechanically carried out.

For the sake of argument, however, let us for a moment accept the *ipse dixit* of the detractors of the process; let us imagine that the coal used costs the same as for ordinary gas making, that the smokeless fuel is of no more value than the ordinary gas coke, that the tar has none of the virtues attributed to it, and will command no higher price than the naphthalene-and-free-carbon-laden product of over-carbonisation; let us boldly face the deficit in ammonia, admit that no one wants a twenty-candle gas with only a trace of sulphur when they can get a fourteen-candle gas with 50 grains of sulphur per 100 cubic feet; let us take the wages as being the same per 1,000 cubic feet of gas as with high temperature carbonisation, and then compare the cost per thousand of the gas as it is being made by low temperature carbonisation at the present moment, with the analysis of the returns of one of the largest companies using high temperature distillation.

COMPARISON OF COST OF 1,000 CUBIC FEET OF GAS MADE BY HIGH AND LOW TEMPERATURE CARBONISATION.

*High Temperature.**

Coal at 11s. 6d. per ton	13·30 pence.
Purification	0·50 ,,
Salaries	0·54 ,,
Wages	2·25 ,,
Maintenance	3·45 ,,
	20·04 ,,
Residuals—	
Coke ·82 cwt. at 12s. 3d.	6·11 pence.
Tar ·9 gall. at 1·5	1·30 ,,
Ammonia products	2·11 ,,
	9·52 ,,
Cost of 1,000 c. ft. of 14 c.p. gas in holder	20·04 pence.
	9·52 ,,
	10·52 pence.
Calorific value, gross	592 B.T.U.
Sulphur, per 100 c. ft.	45 grains.

Low Temperature.

Coal at 11s. 6d. per ton (4 cwt.)	26·50 pence.
Purification	0·50 ,,
Salaries	0·54 ,,
Wages†	2·25 ,,
Maintenance‡	2·21 ,,
	32·00 ,,
Residuals—	
Coke§ 2·4 cwt. at 12s. 3d.	17·64 pence.
Tar 4·6 galls. at 1·5	8·90 ,,
Ammonia products	2·80 ,,
	27·34 ,,
Cost of 1,000 c. ft. of 10 c.p. gas in holder	32·00 pence.
	27·34 ,,
	4·66 pence.
Calorific value, gross	750 B.T.U.
Sulphur per 100 c. ft.	16 grains.

* The high temperature figures are taken from the Gas World Analyses, 1906-07, published January, 1908, and are for one of the great London companies using no water-gas.

† In the low temperature process, 11 men replace 30, so that although double the weight is carbonised, the figure given is well above the actual.

‡ On account of a slightly visible heat being used, maintenance is about one-fourth that of high temperature carbonisation.

§ The low temperature coke yield is two-thirds the weight of the coke taken (68 per cent. as a rule) and 10 per cent. on the weight is allowed for use in the gas generator firing the retorts. In practice, the fuel used consists of "bottoms" and screenings, and rarely exceeds 6 per cent. of the weight of coke produced.

In this comparison the actual returns of the company that has been the pioneer in cheap gas in the metropolitan district have been taken, and no questions can arise as to the prices of coal and residuals, as the same prices are taken for each side of the Table, and yet with every item stated against low temperature working the price of the high candle-power gas comes out at less than one-half that produced as the outcome of a century of practice in our gas works.

The criticisms which will be offered by the supporters of high temperature carbonisation will probably be—

1. That there will be no market for the low temperature coke, as has been shown by the reception accorded by the public to imitations of this smokeless fuel made by the system introduced by Colonel Scott-Moncrieff.

2. That the residual market is already in so depressed a condition that an output of such an increased volume of tar would ruin it, and that the gas under these conditions would be more likely to cost 2s. 6d. per thousand than 4½d.

3. That the day is gone by for high candle-power gas, and that the incandescent mantle does better with a 14-candle gas than with a 20-candle.

4. That the high calorific value of the gas would probably mean a lower consumption, and so recoil on the gas works.

5. That now the sulphur restrictions are withdrawn it does not matter whether there are 18 or 45 grains of sulphur other than sulphuretted hydrogen in the gas.

6. That only half the volume of gas being made per ton of coal, the factors of time and space would render the adoption of the process impossible, and that if it were adopted in spite of this, the gas manager would be robbed of the valuable aid of carburetted water-gas as a stand-by in case of labour troubles or suddenly increased demand.

Let us see what these objections really come to. Taking them in the order in which they are stated, I freely admit that the public are fully justified in declining such smokeless fuel as has been lately put upon the market by one of the gas companies; since it, having been made by the Moncrieff process of carbonising at the ordinary retort temperature and drawing the charge when 5,000 cubic feet have been distilled off, suffers from the drawback that must render all such attempts to make a smokeless fuel abortive.

Anyone who has worked on carbonisation knows that owing to the porous character of

coke it is an excellent non-conductor of heat, and that this is one of the great troubles in gas manufacture, as it prevents the interior of a charge being raised to the desired high temperature without so heating the exterior as to ruin the gas that has to pass through it from the core. When such a charge is drawn after 5,000 cubic feet have been distilled off, it is found that the exterior is ordinary gas coke (every whit as hard to ignite and as slow to burn), whilst the core is largely uncarbonised coal which is by no means smokeless, whilst opening the retort to draw the charge creates such a volume of smoke that the works need to be in a very isolated neighbourhood to make it possible.

The result of the process is that the manufacturer loses half the volume of his gas, and has no increase in quality or quantity of the tar to make up for it, whilst loss in ammonia also helps either to reduce his profits or to put up the price of the fuel. He therefore realises that he might just as well burn a mixture of coal and coke.

Several gas managers have told me that they can make a smokeless fuel by dropping the temperature of their retorts by a hundred degrees or so, and make 7,000 or 8,000 feet of gas per ton. If they try it they will find that in this case also they cannot properly get rid of the smoke-forming compounds from the interior of the charge without coking the exterior, and, what is worse, they will get an oily tar in which the unsaturated hydrocarbons and paraffins will so hamper the separation of the valuable by-products as to make them of but little value, and commercial failure will again result.

Success can only be achieved by boldly dropping the temperature to a scarcely visible heat (400° C.), and when this is done the coke may be kept at it for almost any period without driving out those volatile hydrocarbons that give easy ignition and a smokeless flame, so that, if the charge is properly proportioned, time can be given to carbonise the whole mass to a perfectly uniform product, whilst the tar, as has already been pointed out, is so radically altered in character as to appeal to entirely new markets, and to entail considerably altered conditions of refining. It is these radical changes in the method of carbonisation which are protected, and a study of which has convinced the patent authorities of Germany, America, and England that the process is a novel departure from the well-worn paths of gas and fuel production.

The second objection to the process has been partly answered. Motor spirit, lighting and fuel oils, disinfectants, lubricants, and insulating material, all command a market wider than is the case with the gas tar products, and will have but little effect upon the price of the benzols and anthracene, as unless it is found desirable to "crack" some portion of the low temperature tar with a view to their formation, this tar would never be treated for their recovery.

With regard to the low temperature coke, I have no doubt as to its not only finding a wide and ever-increasing market, but that it will eventually displace coal as a universal fuel. It must be borne in mind that the earnest efforts of the smoke reformers have in the past always been defeated by there being no practical means by which the abolition of smoke could be brought about, and the pollution of the atmosphere, which has become little short of a national disgrace, prevented. The gas-stove offered a solution, but gas was dearer than coal, and there exists a large class of housekeepers whose love for the homely, comfortable, pokable fire will never allow them to give up solid fuel, and who, although they freely admit the importance from every point of view of cleansing the atmosphere from smoke, still decline to further it at the cost of their own pocket or comfort. Now that low temperature coke is available the case is entirely altered, and this most fascinating and effective of fuels should, in conjunction with the gas stove, rid England of the reproach of her smoke-darkened centres of industry, and not only improve the health of the nation, but also bring about an economy in our depleted coal supplies that will materially aid in prolonging Britain's supremacy amongst the nations.

The argument that the day of high power gas has passed is a perfectly sound one, but the fact that a 20-candle gas is made at the works does not necessarily imply that a gas of that quality would be distributed. A gas containing about 60 per cent. of methane specially lends itself to dilution by water-gas, and it has now been amply proved to the gas industry that by the Dellwik process blue water-gas can be made on the works at 3½d. per thousand, whilst if a portion of the low temperature coke were used for its generation, it would itself contain a certain percentage of methane, with the result that a thousand feet of 20-candle gas diluted with 300 cubic feet of water-gas, would yield 1,300 cubic feet of

14-candle gas, with a calorific value of 600 British thermal units, and only 14 grains of sulphur per 100 cubic feet.

The objection that a high calorific value would mean a lowered consumption is met by the last answer; but even if the 20-candle gas were distributed undiluted, everyone with experience of the ways of consumers knows that economy in consumption is the last thing ever studied—the tap is always turned on full, and the only alteration would be that the consumer would get more heat.

The idea that now the sulphur restrictions have been removed the amount of sulphur does not matter, is, to my mind, a most dangerous one for company and consumer alike. The sulphur clauses were repealed on the gas companies showing that when unrestricted the sulphur in the form of compounds other than sulphuretted hydrogen had never exceeded 35 grains, and Parliament accepted this as a fact. No sooner had the clauses been abolished than one company at least, by pressing temperatures to the highest pitch and using inferior coal, made and distributed gas containing far higher proportions, and although other companies were wise enough to retain lime purification and avoid any such excess, a continuance of this policy is quite likely to lead to the sulphur clauses being reimposed, especially if methods of gas manufacture are available which without lime purification yield results well within the old limit.

Twenty years ago Mr. Lewis Wright pointed out the effect which the temperature of carbonisation had upon the formation of carbon bisulphide, and showed that a good gas coal which at moderate temperatures gave 27 grains of sulphur per 100 cubic feet would, when the temperature was pressed, yield over 40 grains. One of the fascinations of still lower temperature carbonisation is that a still greater diminution in sulphur compounds can be obtained.

The objections as to time and space in reality disappear when one considers the fact that although double the quantity of coal has to be handled to yield the same volume of gas as by high temperature carbonisation, yet the space occupied by the low temperature carbonising plant is considerably less than half that taken up by the ordinary retort-house. As has already been shown, blue water-gas would in all probability be employed for diluting the rich gas down to the required standard, and the apparatus could readily be fitted with carburettors for use in cases of labour troubles and fog. As the volume of gas to be dealt with remains the same, the purifying apparatus would need no alteration.

Sixteen to seventeen million tons of coal are annually carbonised in the gas works of this country, whilst over 35,000,000 tons of bituminous coal are used for domestic purposes and the pollution of the atmosphere. If low temperature carbonisation for the production of gas were universally adopted, it would mean that 34,000,000 tons would be carbonised for gas-making purposes, yielding 22,000,000 tons of low temperature coke, 20,000,000 of which would be available for domestic fuel, whilst 3,400,000 tons of tar would be formed, which on distillation would yield 34,000,000 gallons motor spirit, 34,000,000 gallons enriching and burning oil, 2,550,000,000 gallons, or 1,000,000 tons fuel oil, and 1,700,000 tons pitch.

Should it ever come to pass that a general adoption of low temperature distillation provided these enormous volumes of by-products, the fuel oil would be sufficient to supply the British Navy, and render it independent of coal and foreign oil supplies, whilst the motor industry would be free from the fear that oil rings and the decreasing output of petrol would cripple their business. The economy in coal would also be enormous.

HAND-WOVEN COTTON CLOTH IN BRITISH INDIA.

The primitive methods used in India in making cloth from cotton, the methods that were used centuries ago, and that are in daily use by thousands all over India to-day, are as follows:—The cotton is picked by women, the pods exposed to the sun and the husks removed. The women remove all the immature and rotten cotton and then pick out all the free lint possible by hand. The greater part of the lint is freed from the seed by a primitive ginning arrangement, consisting simply of two one-inch wood rollers, revolving together and turned by a small crank on the end of the lower roller. The crank is turned with one hand and the cotton fed between the rolls with the other. The rollers which run tightly together, catch the lint and draw it through while the seed, being too large and hard to pass through, falls to the ground. This primitive gin is now, according to the United States Special Agent of the Department of Commerce who has lately been visiting British India, known in the vernacular as the "churka," and produces from six to eight pounds of cleaned cotton a day. Ten seers (twenty pounds) of cotton in the seed is estimated to yield six pounds of lint cotton, and is an ordinary day's work for one man.

The cleaned cotton is then put out in the sun to dry after which it is carded by a simple contrivance known as a "dhunetta" or "dhania." This operation is performed by means of a bow. The contrivance consists of a bow of hard wood, to one end of which is attached a board. A bowstring passes over a bridge of wood attached to the other end of the bow and is tied to the end of the board. A loop of string, under which the left hand is passed to hold the instrument steady, and a wooden mallet complete the contrivance. The bow is held with the left hand under the loop so that the string just touches the cotton, and the carder with his mallet twangs the string so that it vibrates and strikes the cotton at each twang. The fibre is thus separated, and its texture being loosened flies off in a fluffy condition, and the dirt and dust, which form about one-twentieth of the weight, are eliminated. The next process is spinning. The machine is called a "charka," and is similar to the old spinning wheel used in America in former times, but more roughly made. It consists of a horizontal spindle driven by a band from a hand wheel made with a hub from which project spokes. Every alternate spoke is on the right or left side, and across the ends of these is stretched a cord that makes a track some two inches wide for the driving band to pass over. Cotton in the form of a wick or spool is presented to the point of the spindle and then spun into thread, which is allowed to roll around the spindle. When the projecting point of the spindle is full, the spun thread is removed and rolled round another machine, commonly known as the "latai," which is nothing but a small conical-shaped frame of bamboo. When this pyramidical reel is full, the thread is taken off and wound together in skeins, and is ready for the weaver. From this point onwards the process is the same, whether the yarn is hand spun or purchased in hanks from the factory. The yarn is usually steeped in fresh water for a day or so and then dried. This is done to strengthen it. The yarn is then sized by being taken hank by hank and squeezed in a fluid until the threads are thoroughly permeated with it. In Bengal the fluid is usually made of roasted paddy (khoi) and tamarind, and in Madras of rice flour and gingelly boiled in water. The wet hank is then taken and placed around a "swift," and after this is rolled upon another framework called the "natai," and in going from one to the other is passed through the fingers of the left hand and the superfluous size and water removed. This simple method of sizing enables the size to penetrate the yarn thoroughly, and gives good results. As a rule there are no germicides or antiseptics used, since the climate, except in the monsoon season, is dry and the cloth reaches the consumer quickly after weaving. A good Indian size is made of sixteen pounds rice flour, four pounds sago, four pounds gingelly oil, and sixteen gallons water, boiled together until of the right consistency. It will be noticed that rice flour or starch takes the place of the corn or potato starch used in the United States. Tallow, which is a common ingredient in such preparations in America, cannot be used in India on account of the prejudices of the people. The Hindoo religion touches every detail of their existence, and all ingredients are carefully examined to see if sanctioned by the laws of caste. In most sections of the country the higher castes of weavers cannot use the starch of boiled rice without forfeiting their caste, and whatever starch they use must be of fried or parched rice, called "khoi" or "chira." On the other hand, the low caste weavers would lose caste if they used either "khoi" or "chira," and must use only the starch from boiled rice. The warp is laid out by placing ten stakes in a line, the two end ones being larger than the others, and all about three feet high. The warper then holds the "natai" swift in one hand, and with the other takes the thread from stake to stake, passing it inside one stake and outside the other, and reversing this on the return. This is done until the total number of threads required for the warp is thus laid out, when they are left to dry and stretch. A wide comb is then inserted into the warp at one end, the threads laid in, two to a dent, and the comb moved along to straighten and adjust them. As this comb is moved along, the stakes are pulled up and the threads wound upon the end stake. Three of the intervening stakes are kept and wound upon the central stake with the thread to act as lease rods in keeping the warp in order. The wound-up warp is then placed on the loom, the rods drawn in through the heddles and the reed, and the weaving started. The filling in the meantime has been wound on small quills by means of the spinning wheel and is placed in the shuttles. The shuttles used vary according to the district and the individual taste of the weaver, and are usually made of hard tamarind wood. In some places using the old throw-shuttle loom, there is neither shuttle nor quill employed, but the yarn is wound from end to end of a short, oblong wooden piece which has a short iron spike in each end. This is thrown through the shed from hand to hand, and an amount equal to the length of pick is unwound each time before throwing. This is more used for weaving carpets, however, than for weaving ordinary cloth though sometimes it is used for the latter. A large amount of the hand-woven cloth is of household manufacture, simply for the use of the weaver and his family. There is very little interchange of merchandise from hand looms between different districts, not anything resembling the great trade between Shanghai and Manchuria in the Chinese "nankeen." Most of the cloth that is transferred from one district to another in India, is either fine muslin or "bulbuls," or cloth that is only partially loom woven—that is, cloth decorated on the loom by needle. Usually only enough yarn is spun in a locality to meet the needs of that district, and it is the same with the ordinary cloth made. The greater part of the cloth woven by the professional weavers is sold in their own or the neighbouring villages. "Dalals," or brokers, are the medium for effecting sales between the weavers and

the shopkeepers in many localities. Sometimes a weaver who is a little better off than his fellows buys up the surplus production of the village, and retails it at the nearest villages, or hawks it through the streets of a large neighbouring town, going from house to house and from store to store. Fine cloths are sold through dealers, and in the majority of cases are contracted for beforehand, the dealer supplying the cash in advance for buying the yarn and for wages, and the weaver agreeing to make a certain number of yards at a definite rate per day.

INDUSTRIAL CHANGES AND DEVELOPMENTS.

Under the above heading, the Annual Report of the Chief Inspector of Factories and Workshops, just published (Cd. 1166), refers to the increased employment of little girls. Touching upon this development, Miss Squires says that numerous cases came under her observation, as well as that of other lady inspectors, which point to a need for increased watchfulness in the Midlands and in Yorkshire, over the health and safety of young girls in factories and in workshops. With the increase in the use of machinery for all kinds of processes in non-textile factories, the employment of little girls, who have just left school, is noticeably changing from mere warehouse processes, such as wrapping up and packing, to the tending of machinery. In the textile districts of Yorkshire, children (both half-timers, and those who having left school, are technically young persons) are in such demand that all who are qualified are employed. The good wages they earn in the mills make them by no means so submissive to parents, teachers, and masters, as they desire. Children, and young persons of 13 or 14 years of age are also found in this part of the country employed in the laundries and dressmakers' workshops, because the older girls and women are all absorbed by the mills, and the employers cannot get grown-up workers. Miss Squires says she has recently inspected a number of factories and workshops which looked more like a school than a place of business, room after room being occupied by little girls in short frocks and long hair. Among these, were a steam laundry, a lithographic printing factory, a cardboard-box factory, a hearthrug weaving works, wholesale clothiers, a drug warehouse, and a hook and eye factory. Miss Lovibond had her attention specially drawn to the excess of demand over supply in the case of girl workers in the Bradford district. On enquiry, various causes for the difficulty of obtaining young girls came to light. In addition to the general trade being good in the woollen and worsted trades, owing to the condition of the work received during the last few years, there has had to be a great increase in the "burling," *i.e.*, in the fine darning or mending the cloth when woven. This is attributed to the increased amount of foreign matter in the Australian wools, due to skips of poor quality being used. It was stated at a meeting of the Bradford District Wool Association that "whereas a few years ago the number of burlers employed in Bradford was 1 to about 20 looms, the proportion to day is one to five looms." One little girl told Miss Lovibond that she began to work at weaving on her thirteenth birthday, and had been working five months. Her employer said she earned more than many of the women in the shed. In another case a girl of 14 was in charge of three looms (cotton), and earned 14s. to 16s. a week all the year round. For such young girls the strain of working in the weaving-shed must be great.

Miss Squires touches on the physical results of increased employment in some directions of young girls on machinery or processes hitherto entrusted to women. At a large clothing factory in Leeds she found a great many little girls employed on the sewing machines. They were working five-needle quilting machines, machines which are usually worked by young women. One of these girls was very small and thin and had a very nervous, strained look. They were earning 9s. and 10s. a week—a woman's wage, as the manager said. This wage is made up of various items of $1\frac{1}{2}$d. and $1\frac{3}{4}$d. each, and shows a rapidity usually only acquired by a woman after considerable practice, and which must mean a good deal of nervous strain in such young girls. There were also four little girls aged 13 employed on the balance pressing iron. The girls were so small that they could only just reach the iron, and as they are standing all day, and jumping on the treadle to get sufficient pressure, the work seems very unsuitable. Unfortunately, the work is frequently not disclosed to the certifying surgeon when he examines the girl, or, more commonly, her probationary period on some light warehouse work is not completed until after his visit, so that the certificate of fitness for employment is not given with any reference to the nature of the work upon which she is in the main to be employed.

THE BELGIAN LACE INDUSTRY.

Lace-making is practised in all the provinces of Belgium with the exception of Liège, but the two provinces of Flanders are the principal seats of this industry. Out of a total of 45,500 lace-makers in Belgium, West Flanders has 25,500, and East Flanders 18,200. The art of lace-making is still actively engaged in by the Flemish population, who have shown great skill in all kinds of needlework. In certain districts it may be said that all women, young or old, handle the bobbin or the needle, and where the manufacture of lace has fallen back before the invasion of other industries, it still possesses a certain popularity. Lace is made at home, almost always by women, and is sold through local middlemen, who alone deal with the lace-maker, and who supply the so-called manufacturers or contractors. The lace-makers work, as a rule, to order and by contract, and are paid by the piece. They reside

mainly in the different villages of the provinces of Flanders, while the contractors are located in Ghent, Bruges, and especially Brussels. Lace is divided into point and pillow lace, the latter, according to the American Consul-General at Brussels, so-called on account of its being made on pillows or cushions. Three essential agents co-operate in the manufacture —first, the commercial contractor or manufacturer, who centralises the production of certain articles for which he has received orders, or the sale of which he foresees, which are almost entirely manufactured outside of his premises. He stributes his orders among his middlemen, and rarely supplies raw material. Second, the middleman, or person who is between the lace-maker and the commercial contractor, being sometimes an agent and sometimes a representative of a convent. Third, the lace-maker, who works at home, and never comes in contact with the manufacturer for whom she works. She receives her design and pay from the intermediary agent. The majority of the lace-makers earn from 5d. to 9d. a day. Exceptionally good workers earn 10d., and expert workers, of whom there are only 10 or 12 out of 15,000, 1s. 8d. a day, for no matter what kind of lace. The mother sometimes initiates her daughter in the manufacture of lace which she has practised herself from childhood, but as a general rule she no longer teaches the latter the trade, but sends her to a neighbouring lace-making school, where the child is taught to make the lace she prefers. There are 160 schools for lace-making and embroidering on tulle in Belgium, of which three-fourths are managed by nuns. Notwithstanding the success which Brussels lace has had, the future of the industry does not appear very bright. Every year the number of lace-makers decreases to an alarming extent. Events of an economical character, fashion, competition of the numerous mechanical imitations, especially those of Venice, Chantilly, and of Valenciennes, and the defective commercial organisation of the lace industry, have contributed to harm it. Owing to the system of intermediary agents, by which some agents grow rich and the lace-maker receives barely sufficient wages to keep soul and body together, the trade is yearly becoming less and less popular, and lace-makers are beginning to take up more profitable occupations. The exports of lace from Belgium in 1905 amounted in value to £266,000, and in 1906 to £303,000, while in 1907 they amounted to £368,000.

WATER-POWER IN FRANCE.

The idea of utilising the latent forces of the Rhône is no new thing, but the development of the actual use of water-power in France—" white coal" as it is sometimes called—is next perhaps to the growth of the motor-car industry, the most remarkable feature in the industrial history of France during the last half-century, and though less than ten years old, has attained extraordinary proportions. Every year, says Mr. Consul Vicars, referring more particularly to Savoy, Dauphiné, and Jura (No. 4066, Annual Series), fresh streams are laid under contribution for hydro-electric power, and the traveller notes the enterprise and progress of which these works are the visible sign throughout the region round Grenoble. The total water-power contained in the Alps to-day is put at nearly 300,000 horse-power. Opinions differ as to the total latent power still available, but even the lowest computation puts the yearly average obtainable at 2,300,000 horse-power, while the Chief Engineer of Transports, Monsieur Tavernier, estimates it as high as 15,000,000 horse-power. The works, says Mr. Consul Vicars, are of two kinds. The first consists of factories engaged in the electro-metallurgical and electro-chemical industries, and utilising water-power obtained by them on the spot for the manufacture of aluminium, calcium carbide, ferro-silicon, &c. These at present utilise over 100,000 horse-power in Dauphiné alone. The other kind consists of the enormous power stations pure and simple for supplying current, not only to various works in the neighbourhood, but within an ever-growing radius. Lyons is lighted by power from the Volta works at Montiers belonging to the Grenoble Power and Light Company, which sends 6,000 horse-power over a distance of 112 miles under a pressure of 57,000 volts, while from Lyons to Valence the whole Rhône valley is fed by power stations situated in the Departments of the Savoy and Isère. Even St. Etienne and Roanne, in the Department of the Loire, will before long be using electricity generated far away on the other side of the Rhône, in the valley of the Drac, a tributary of the Isère.

A Paris company have made proposals to the French Government for the construction of an enormous barrage, 230 feet in height, across the Rhône below Bellegarde, forming above stream a reach of 14 miles long from the dam to the lake, and down stream a greater waterfall, from which it is proposed, by means of hydro-electric works, to obtain over 100,000 horse power for transmission to Paris. The company further offer to construct, at their own expense, the necessary works to enable boats to pass through the dam. If this were done, the town of Geneva would only have to make its own barrage at Chèvres (some four miles from Geneva) passable for boats, in order to open up navigation between the lake and Lyons. An alternative suggestion has been made—that the dam should be connected with the lake by a canal, wholly in French territory—reaching its shores somewhere in the neighbourhood of Thonon. This would involve the construction of a costly canal, but it is urged that the additional expense would be more than outweighed by the advantages, as by this means it would be no longer in the power of the Swiss to do what they please with the river before it enters French territory. If the present rate of progress be maintained, in a few years the whole of France will be supplied with hydro-electric power from a few distributing centres. The industrial importance of such a development would necessarily be very great.

ARTS AND CRAFTS.

Furniture and Wall-papers at the Franco-British Exhibition.—It is only natural in a big undertaking like the Franco-British Exhibition to expect the decorating and furnishing trades to be well represented. There certainly is a good deal of furniture of one kind and another to be seen. The French and English exhibits are somewhat strikingly different, even in the Decorative Art Palace—and, if we include the Pavilion André Délieux, the contrast is still more strongly marked. It is a pity that the furniture exhibited does not more adequately represent the work being done on both sides of the Channel, as it is, they cannot profitably be compared. For, whilst present day French furniture of a very modern type is shown in the Pavilion Délieux, almost the only English furniture which is not made on strictly traditional lines is that shown by Messrs. Morris and Co.—which, by the way, coming as it does in the Loan Collection amongst the old styles, makes one wonder for the first moment or two what has happened, and whether Morris's productions must already be included in a retrospective collection. It was perhaps inevitable that at the present moment when English work of the seventeenth and eighteenth centuries is so much the fashion, the bulk of the British furniture should consist of reproductions more or less exact of the older styles—but it is to be regretted, for all that, that the more modern English work is not more fully represented. There is plenty of good workmanship in the English section, from Messrs. Hampton's fine reproduction in massive oak of a part of the hall at Hatfield, to the light, almost too light, satinwood furniture in the style of the eighteenth century. The trouble is not that the quality of the work shown is below the mark; in its way, it certainly is not, but that it represents, on the whole, only one side, and that the least progressive one, of present day British manufacture. So much has been done in recent years on distinctly new lines that it is disappointing not to see more of it at the Exhibition. The little exhibit of Messrs. Morris and Co., which includes furniture from the designs of Mr. George Jack (whose inlaid cabinet, though it may be "Sheraton finish," is yet distinctly his own), of Mr. Mervyn Macartney, and of Mr. W. A. S. Benson, is a very good example of what is being done by a group of men who know how to be themselves and of their own period without being aggressively modern, and who, while not tightly bound by what has been done before, do not by any means disdain to look at old work.

The French work in the Palace of Decorative Arts is almost entirely on old lines—the Empire style is very much in evidence—and the furniture is, moreover, so badly shown, almost every inch of space having been filled up, that the general effect is not, on the whole, very pleasing. It is somewhat of a relief to turn to the well-arranged little rooms in the Pavillon André Délieux. It would be difficult here for any one to complain of too strict adherence to tradition. The French architects and decorators who exhibit their furniture are certainly not hampered by any too great respect for what has been done in the past. It is not that the furniture is generally extravagant in design—though the library table of MM. Sauvage and Sarazin, practical as it no doubt is, is a trifle extravagant—but that it is, in the main, on the side of simplicity and severity. The chairs do not all look particularly reposeful, and the simplicity is at times rather mannered, perhaps, but for all that one cannot but feel that something is being done in the way of producing modern work which is of its own time without being too aggressively so. It is, therefore, all the more to be regretted that there is so little English work shown which can be fairly compared with it.

The few French designs for wallpapers exhibited show unmistakeable signs of the influence of M. Grassett. The French wallpaper manufacturers do not, apparently, exhibit at all. Four or five of the leading British paper stainers have stands in the Decorative Art Section, but they appear to have contented themselves, for the most part, with showing patterns which are distinctly French in character. There are, of course, exceptions to this rule, notably in the case of Messrs. Jeffrey and Co., who have a paper designed by Mr. Walter Crane in the centre of their exhibit, and who show also damask patterns and various distinctly English designs. For some time, now, it has been possible to get really excellent designs in English wallpapers. It is, therefore, matter for regret that on an occasion which offered such a good opportunity for showing what can be done over here, so many of the exhibits are mainly taken up by little stripe, spot, and other rather trivial patterns of a kind which the French can do to perfection—but which, when attempted by Englishmen, lack the little touch of distinction which makes them really worth taking into account. We should surely have impressed our rivals across the Channel much more favourably by showing them good work on our own lines than by offering them second-rate versions of the kind of thing they can do so well themselves. Imitation may be the sincerest form of flattery—but do we on an occasion like this, particularly wish to flatter?

Colonial Arts and Crafts.—It was impossible not to wonder whether, either of set purpose or incidentally, the British Colonial Sections of the Exhibition would have much to tell us of what was being done overseas in the way of Arts and Crafts. The Indian section includes a good many objects of art which go to prove that the arts in India are not allowed to languish, and that European influence is not unduly apparent in them. But there is nothing amongst the objects shown which calls for special notice. The native work from some of the Crown Colonies is interesting in its barbaric kind of way, notably the printed cottons from Ashanti and Southern Nigeria and the handwoven cloths from the Gold Coast Colony and Gambia—which are very good in colour. These last, by the way, are quite as

attractive as a good deal of the modern English hand-loom weaving, and presumably could be produced at a much lower price. Australia and New Zealand exhibit a good deal of timber, some of it really beautiful in its markings—but their furniture is on the whole heavy and ornate; in fact, it is hardly worthy of the wood, which would be more effective if it were more simply treated. Some of the furniture from Queensland, however, seems to show a leaning towards simplicity, which is all on the right side. The jewellery from New South Wales includes, in addition to the well-known type of work, a certain proportion of exhibits which have clearly been influenced by the "new art" movement. The Australian stones and minerals are so beautiful and offer such scope to the jeweller with an eye for fine colour, that it is to be hoped the colonial goldsmiths, having once begun to move off the beaten track, will in time develop a style of jewellery which will be their own, because specially suited to their material. Such a wealth of mineral products of such truly glorious colour should afford a fine field for a jeweller of taste.

The only colony which has devoted a special section to "Handicrafts" is Canada, whose exhibit is under the management of the Canadian Handicrafts Guild, a society which seems to be run somewhat on the lines of our Home Arts and Industries Association. In a country which includes so many nationalities the exhibits are naturally varied in type, though they consist for the most part of needlework, weaving, and basketmaking, this last practiced, of course, by the Canadian Indians. The portières, &c., made in the "tufted" weaving of the French Canadians are characteristic and effective, but the most striking exhibits are a series of mats, &c., partly in drawn thread work, ornamented in simple patterns with bright coloured silk embroidery, mostly in blue and red. It is rather difficult at first to place peasant work of this type in Canada, and it is not until we learn that this is the work of the Doukhobor women that we realise that its character is really Russian.

Russian Handicrafts.—It is a far cry from the Doukhobor work to the Russian peasant work from Smolensk exhibited under the auspices of Princess Marie Tenicheff at the Albert Hall. The purely arts and crafts exhibits there consist also largely of embroidery—and very characteristic embroidery too. This is mainly drawn thread work of a rather coarse kind. The ground threads are often of a dull drab or some other rather neutral colour, but the subsidiary threads introduced to help make the pattern, instead of being like the ground are often of different colours, with the result that the work looks extraordinarily unlike the ordinary drawn thread work which is all in one tint. The tints are, perhaps, a trifle dingy (they are presumably from home-made vegetable dyes) but the colour effects as a rule are far from unattractive. The wood-work shown is very rude indeed in execution—but it is interestin in design, and at times so Eastern in appearance that one would have expected it to come from Asiatic Russia rather than from Smolensk.

CORRESPONDENCE.

MAHOGANY.

Sir George Birdwood has kindly supplemented my article on this wood, and I am glad to find that, in spite of the many pitfalls, my statements are not controverted.

As a practical man, there is always before me the painful confusion which exists as to the nomenclature of timber.

The student finds it difficult to obtain reliable data combining botanical with commercial names. I have before me a botanical work which has been accepted as a text-book, yet it abounds in a most palpable manner with the grossest errors as to commercial names and commercial economy.

If I have not misread Sir George Birdwood's remarks, I feel that he does not sufficiently accentuate the actual differences betwixt cedar and mahogany—the former being botanically coniferous, and the latter deciduous, whilst in commerce no expert can fail to determine their inherent difference. Hence I regret to note that common names, Bastard Cedar, Red Cedar, and Mahogany are given interchangeably to each.

Then Sir George classes the African mahogany as another Meliad or Cedrelad. I cannot profess to follow all the synonyms of botany, but it does appear to me that much of the wood is really a mahogany, and therefore it should not be classed with the cedars. Of course there is small quantity of cedar shipped from Africa, but there should be no difficulty in determining botanically the respective classification.

As to the remark under the heading "Cedrela Toona"—"the timber in no way inferior to mahogany." I may say that for many years I have never missed an opportunity of inspecting many sample shipments of Asiatic timber, but have invariably found that they lack the essential characteristics of the *Swietenia Mahogani*, or even the best shipments of African mahogany. The Asiatic timbers which I have examined lack the warmth of colour, evenness of grain, and cleanness of texture common to the former.

The commercial world may be somewhat prejudiced and slow to take up a new wood, but it is not stupid and will not fail to adopt a wood which in every way meets its requirements. This fact is exemplified by the way it has taken up within the last twenty years the African mahogany.

If there are any East Indian timbers (outside of teak) which possess the ideal conditions, requisite in a furniture wood, there is in store a gold mine for those who exploit them, providing they can be put on the market at competitive prices.

FRANK TIFFANY.

OBITUARY.

Sir Thomas Brooke, Bart.—Sir Thomas Brooke, a foremost citizen of Huddersfield, died on the 16th inst. He was the son of Thomas Brooke of Northgate-house, Honley, Huddersfield, and born on May 31st, 1830. He was a director of the London and North-Western Railway Company, and for a time Chairman of Quarter Sessions for the West Riding of Yorkshire, and Lieut.-Colonel commanding 5th Battalion West Riding Rifle Volunteers. Sir Thomas Brooke was in business as a woollen manufacturer from 1854 to 1879, and was created a Baronet in 1899. He was elected a member of the Society of Arts in 1861. He was a book collector, and possessed a fine library, and was a member of many antiquarian and literary societies. The funeral at Armytage Bridge took place on Monday, 20th inst., and was largely attended by representatives of the various religious, charitable, business and antiquarian institutions with which Sir Thomas was connected.

GENERAL NOTES.

Rubber Exports from Brazil. — For some years, extensive demand and the absence of competition raised the price and increased the output of Brazilian rubber. But last year the increased production of rubber in other parts of the world and the falling off in demand in proportion as prices rose caused a reaction in prices. The financial crisis in the United States at the close of 1907, and the consequent cancelling of orders, had such disastrous results on the industry, that, in view of the heavy expense of output and taxation to which Brazilian rubber is subject, present prices do not give sufficient margin, and shipments are consequently restricted. In his report on the trade and commerce of Brazil for last year (No. 4054 Annual Series) Mr. Consul-General Chapman shows a steady and continuous fall in price of fine Para rubber per lb. In May, 1905, it was quoted 5s. $9\frac{1}{4}$d., at the end of that year it was 5s. $5\frac{1}{2}$d.; in December, 1906, it was 5s. $2\frac{1}{2}$d., at the end of 1907 it had fallen to 3s. $3\frac{3}{4}$d., and at the date of Mr. Chapman's report of this year it was 3s. In 1906 the exports amounted to 34,960 tons, of a value of £13,899,809. Last year the exports had risen to 36,490 tons, but the value had fallen to £12,644,387. Of the total exports, the United States took 16,811 tons, and the United Kingdom 14,354 tons.

British Trade in Crete.—Reporting upon the trade of Crete, Mr. Vice-Consul Wyldbore Smith says (No. 4056, Annual Series) that if British trade with Crete is to be maintained and extended, British commercial houses must understand that it is not sufficient for them to obtain the names of local firms interested in their particular line of business, and then flood them with their catalogues, in which the measurements are in yards and inches, or the weights in cwts. and lbs., while the prices are quoted in pounds, shillings, and pence, all of which are probably incomprehensible to the small dealer. The result is that the would-be client of British firms turns to a catalogue from, say, a German firm, where he will probably find exactly what he wants, quoted in his own language or under such commercial synonyms as he is acquainted with, and where, moreover, the weights and measurements are given in accordance with the metric system, and the prices in decimal coinage, all of which he can understand. It is not surprising that such a dealer places his custom with the house which is so plainly desirous of adapting itself to his wishes. British trade will continue to be severely handicapped so long as British firms refuse to send competent travellers, able to make themselves understood, and provided with a plentiful stock of patterns such as might be likely to find a sale, and so follow the example of their German, Italian and Austro-Hungarian rivals.

Optical Convention, 1909.—The Permanent Committee, appointed by the First Optical Convention in 1805, is now making arrangements for holding the Second Optical Convention in London, in May, 1909. The main objects of the Convention of 1909 will be similar to those of the first Convention, but it is hoped—with the vigorous support of the trades and industries concerned—to carry them into effect over a wider field. The Convention is intended to bring into close touch, and to foster the mutual understanding of, those interested in optics and in optical and other scientific instruments, from the various points of view of manufacturer, retailer, designer, and user. The subjects and instruments to be included in the exhibition and catalogue, and in the papers and discussions of the Convention, will cover all optical appliances and applications of optical methods and principles, as well as scientific instruments and apparatus of an allied character. This latter class will include, for example, such instruments as are used for meteorological purposes or for accurate measurement in laboratories and workshops. The interests of the various sciences and branches of technology concerned in these subjects will be met by a series of meetings, at which papers will be read and discussions held, which will be subsequently published in a Volume of Proceedings of the Convention. The great value of the Volume of Proceedings of the Convention of 1905 is generally acknowledged, and would alone justify the Committee in appealing for wide support. An exhibition of instruments will be arranged, which will be scientific in character, and will consist principally of instruments manufactured in this country; it will be designed to display recent progress, and to stimulate future effort. A Guarantee Fund has been started to enable the programme to be carried out adequately. The President is Dr. Glazebrook, F.R.S., Director of the National Physical Laboratory.

Journal of the Royal Society of Arts

No. 2,907. VOL. LVI.

FRIDAY, AUGUST 7, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

EXAMINATIONS, 1909.

Next year's Examinations will commence on Monday, March 29. The last day for receiving entries will be February 23.

The examinations are now arranged under the following stages :—Stage I.—Elementary; Stage II.—Intermediate; Stage III.—Advanced.

The subjects include :—Book-keeping, Accounting and Banking, Shorthand, Typewriting, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Handwriting, and Modern Languages.

In the Advanced and Intermediate Stages First and Second-class Certificates are granted in each subject.

In the Elementary Stage Certificates are given in each of the subjects enumerated. These are of one class only.

In Rudiments of Music Higher and Elementary Certificates are given; in Harmony Higher, Intermediate, and Elementary Certificates.

A fee of 2s. 6d. is required by the Society from each Candidate in each subject in the Advanced and Intermediate Stages, and in the Elementary Stage a fee of 2s. for one subject, and 1s. for each additional subject taken up by the same candidate. The fees for Harmony and Rudiments of Music are the same as for Stages II. and III.

The special subject for Commercial History and Geography for 1909 will be "South and Central America."

Examinations are also held in the Practice of Music, and Vivâ Voce Examinations in French, German, Spanish, Portuguese, and Italian.

The programme for 1909 will be issued about the beginning of September.

It is not proposed to make any alterations of importance.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

FUEL AND ITS FUTURE.

By Professor Vivian B. Lewes.

Lecture IV.—Delivered March 30th, 1908.

We have seen that when gasifying bituminous coal we can obtain as much as 80 per cent. of the heat present in the solid fuel in the producer-gas made from it, and that in practical working 40 to 50 per cent. of this can be utilised for heating purposes, whilst when we come to consider the generation of power we find that the internal combustion engine offers such further economies that it is small wonder that on the Continent the use of steam is being rapidly superseded.

At the time when Siemens did his historical work on regeneration, the gasification of coal was utilised merely as an end to facilitate its adaptation for heating purposes in metallurgy and various manufacturing purposes, whilst the last ten years have seen poor producer gas achieve far greater conquests in the production of power.

The history of the gas and oil engine is one which is rich in the triumphs of perseverance and engineering skill, and those who knew the early forms of the Otto and Langen gas-engine find it difficult to realise that it can have been the progenitor of those magnificent examples of engineering skill that are capable of developing powers up to 2,000 horse-power.

In the early forms of gas-engine, which rarely exceeded 3 horse-power, coal-gas was the only fuel used, and, although Siemens had experimented with it, it had never crossed the mind of any other experimentalist that it would be possible to replace the product of the distillation of coal having upwards of 600 British thermal units per cubic foot heating value,

with gas so low in thermal value as the producer-gas or semi-water-gas which had worked such a revolution in heating. When, however, in 1879 Mr. Dowson showed that the semi-water-gas now generally known by his name could be satisfactorily employed, at once modifications began to be introduced that eventually led to the present type of engine with high compression of the charge, and improvements which have resulted in efficiencies of from 26 to 32 per cent.

As we have seen, semi-water-gas, made by the passage of a mixture of air and steam over incandescent fuel, has a calorific value approaching to 150 British thermal units per cubic foot, and of this practically only one-third is combustible gas; whilst the presence of the diluting nitrogen, which at first was looked upon as rendering the gas unfitted for such purposes as power production, proved not to be the insuperable objection that was supposed, but in reality allowed the high degree of compression to be employed, which has been one of the great factors of success in the modern gas-engine.

At the present time the fuel developments of the last decade have settled down into the production of power-gas for large works by plants of the Mond type, whilst when the power needed amounts to only a few hundred horse-power, a suction gas plant is employed.

It will be remembered that in the early experiments of Bischof and Siemens it was the suction of chimney shaft which drew the air through the incandescent fuel to form producer-gas, and in the suction plant the same idea is utilised, but the drawing of the air through the firebars by a flue was replaced by the idea of causing the suction of the piston in the gas-engine not only to draw gas from the generator to the combustion chamber, but also to aspirate air and steam into the fuel in the generator, so that in its working the engine would bring about the making of the gas needed to continue its action.

The success for small powers of this method of working has made almost as great a revolution in gas-engine work as did Dowson's great discovery, and it has been the prime factor which has led to the dethronement of steam in most of the Continental factories.

The inception of this form of plant dates back only to 1894, when Benier fitted a suction pump to the side of his engine cylinder and drove it off the flywheel, sucking the gas from the generator and compressing it into the engine cylinder, leaving a lowering of pressure in the generator to suck air and water vapour into the fuel, and so keeping up the supply of gas. Very shortly after this those great engineers, the Messrs. Pintsch, brought out a complete plant, in which the steam for the generator was produced by the hot gas from the producer in a small tubular boiler, which was thus made to perform the dual function of cooling the gas and giving the necessary steam. The steam, as it was formed, was drawn with air into the grate of the generator and passed through the fuel. The gas after this partial cooling was passed through a scrubber and purifier, and then on to the combustion chamber of the engine.

Since then many forms of suction plant have been introduced, of which the Dowson and Crossley plants may be taken as types, and although much yet remains to be done, it is quite clear that the suction plant will very shortly become as universal here as it is on the Continent.

The drawbacks to the suction plant are that in starting the generator has to be got up to the right temperature by means of a hand blower or steam injector, that the engine has to be started either by hand or compressed air, and that where space is at all limited, the fuel used is practically restricted to anthracite or coke, as any bituminous coal gives rise to tar vapour, the difficulty of eliminating which from a gently flowing stream of gas necessitates the use of somewhat bulky washers and condensers. The cleanliness of the gas is an absolute essential, as the smallest trace of tar causes sticking of the valves, and brings the engine to a stand.

The advantages on the other hand are so great as to make up for these troubles, and amongst them the wonderful elasticity which in a few minutes enables the generator to be working satisfactorily from a low to a high yield or *vice-versâ*, and the smallness of the stand-by loss when not doing work, are those which appeal most to manufacturers, whilst the economy of fuel is very great, the average consumption being 1 lb. of anthracite per British horse-power hour.

What is now needed to complete the success of the suction plant is a generator for a small-sized plant which will be available for use with bituminous slack, so as to rid the manufacturer of dependence on the costly anthracite, and it is in this direction that a large amount of work is being done at the present time.

The factors which make this a problem of the greatest difficulty, are two in number—

first, the elimination of the tar produced, and, second, the fact that although a non-caking coal can be used, directly a caking variety is employed, the fuel swells and forms an arch in the top of the generator, below which are produced cavities, clinker, and other causes of trouble. These at once interfere with that uniformity in the composition of the gas which is essential to the smooth working of the engine.

The latter trouble can be surmounted for a certain time by the selection of the coal, although this eventually would narrow down the market and increase the price, but the tar offers a problem which will be found extremely difficult to solve. Most of the attempts at present have been made in the direction of either returning the hot tar-laden gas to the bottom of the generator, and making it again traverse the mass of incandescent fuel in order to break up as far as possible the tarry hydrocarbons into hydrogen with deposition of carbon on the coke surfaces, this being done in such plants as the Duff-Whitfield, or to feed the slack by a spiral stoker or other device to the bottom of the generator, so that as the gas and tar distil out they have to pass through the incandescent fuel, the Boutillier suction plant being a good illustration of this type of generator.

Those who have had experience with the trouble of ridding coal-gas of tar mist will sympathise with the difficulties that have to be met, and, as I pointed out when describing the composition of smoke, it is the fact that this tar mist consists of excessively minute vesicles that give it its wonderful floating power, and this makes it very difficult to remove from the gas. In the various forms of washer employed in the suction plant to get rid of this trouble, the centrifugal wringer combined with water spray is found to be one of the most effective means.

My own opinion is that in the long run the same solution will be found to this trouble as will solve the smoke problem, and that is, that the fuel for the small suction generator will be prepared in the gas works by low temperature carbonisation. It will then be found that the low temperature coke is specially fitted for the work, giving a bright combustion under the lowest possible load, and so small a trace of tar that it can easily be dealt with. For works capable of utilising the heat and power from the gasifying of anything near 100 tons of slack per diem, improved Mond generators and plant fitted for ammonia recovery give such enormous economies that, even with only 1 per cent. of nitrogen in the slack used, the ammonium sulphate recovered practically pays for the fuel.

The early engines of the explosion type were all gas-engines, and it was generally assumed that it mattered but little whether they were used with true gases or vaporised hydrocarbons; but as the principles began to be more thoroughly understood it was realised that considerable modifications in design had to be made to construct engines suitable for the various grades of fuel to be used.

In considering internal combustion engines using liquid fuel they naturally fall in the first place into two main divisions :—

I. Those using hydrocarbons volatile at nearly air temperature.

II. Those using hydrocarbons having a flash point above 73° F.

To the former belong all those of the motor-car type using "petrol" in which the motive power is produced by the explosion of a mixture of air and hydrocarbon vapour. In this class the production of the explosive mixture presents little or no difficulty, as it is sufficient to pass air over or through the hydrocarbons of low boiling point known as "petrol" for enough of the vapour to be taken up to yield "air-gas," which alone will burn like ordinary gas, and when further diluted with air, will give an explosive mixture. The efficiency of the petrol motor however rarely exceeds 22 per cent., and as it takes about 0·55 lbs. of petrol per British horse-power hour and the price of petrol approximates to 1s. a gallon, it cannot compare with other sources of power in price.

Up to 1872 all internal combustion motors used highly volatile petrol, benzine, or gas, but in that year Brayton made an engine in America using lamp oil, and that was introduced into England about 1876. In order to use these heavier oils they have to be converted into a fine spray or mist, and this, mixed with the air in the cylinder and compressed, is converted by heat into a gaseous mixture which is then exploded; or else the oil must be gasified in an external vaporiser by heat, and the oil-gas mixed with the air in the cylinder. There are three ways in which the desired result may be obtained :—

I. Oil mist sprayed and mixed with air *before* reaching cylinder—as in the Priestman and Crossley engines.

II. Oil sprayed into compressed and heated air in cylinder—as in the Diesel.

III. Oil gasified by heat and mixed with air.

The grades of oil fitted for use in these engines widely vary, some requiring pure lamp oil, whilst other engines can be run on crude oils, and even on the high flash point oils used as liquid fuel.

In the Service, engines using heavy oil are being largely introduced for auxiliary work afloat, and some of the newer ships have several 160 h.p. engines of the Diesel type, in which compression is very high, and tends to economy in working, the efficiency being as high as 32 per cent.; but where trained engineers are not available to look after the engines, such high compression has its drawbacks, and recent developments in engines using oils of the cheapest description are often preferred, although the efficiency is not so high.

In these latter engines, many troubles due to the deposition of carbon on the walls of the vaporiser and other parts of the engine, are liable to arise, and in Crossley's lampless oil engines troubles due to this source are overcome by spraying in water to the vaporiser. The quantity admitted is automatically regulated at the same time as the oil spray, according to the load at which the engine is running; this prevents overheating of the vaporiser, and the accumulation of carbon.

In considering the economies given by the gas-engine, we must, in order to gain a comparison, glance for a moment at the amount of fuel consumed in developing power by means of steam.

In the best form of triple expansion engines, working with the most economical forms of boiler, it is possible to get the consumption of coal down to 2 lbs. per horse-power hour, but very few indeed such engines exist in comparison with the far more wasteful types driven by boilers, the construction and consumption of which are so inimical to economy that it is possible to find cases in which the coal consumption per British horse-power hour would amount to very nearly 20 lbs. Such cases are of course rare, but they exist. If the average consumption per horse-power were taken throughout the country, it would be found that 5 lbs. per horse-power was a low estimate to place upon the consumption of coal for power purposes.

As has been pointed out before, it is not the absolute calorific value of the fuel that governs the heat or power that can be derived from it, but the efficiency of the heat engine that we employ; and when coal is used for raising steam and converting the pressure developed into mechanical work, we find that 8·6 is about the best efficiency that we can obtain. However, by replacing the steam-engine by the steam turbine, this figure can be raised to 12; so that, instead of utilising the 14,600 British thermal units present in a pound of coal, under the present conditions we are utilising only 1,776, even when employing the most modern developments of boiler and turbine.

We may now collect the data as to cost for the generation of power by the different systems, and tabulate them as follows:—

Cost of Fuel for the Production of 1 British Horse-power Hour.

	Efficiency.	Fuel Consumption per B.H.P. hour.	Cost in pence per B.H.P. hour.
Coal (steam-engine)	8·6	2·0 lbs.	0·2
Coal (turbine)	12·0	1·7 ,,	0·17
Oil (Diesel)	32·0	0·6 ,,	0·2
Oil (Crossley)	22·0	0·6 ,,	0·3
Petrol	22·0	0·55 ,,	0·94
Power-gas	31·0	80 c. ft.*	0·1
Coal-gas	31·0	16 c. ft.*	0·3

When we consider that the average consumption of coal at present is 5 lbs., we see from the above Table that under anything but ideal conditions it would be quite easy to reduce the consumption to one-fourth for the same output of power as is being used to-day, and as the consumption of coal for power purposes amounts to 52,000,000 tons per annum, this would mean a saving of 39,000,000 tons a year, whilst the proper utilisation of blast furnace and coke oven gases would effect enormous savings if they were converted into electricity, which wonld be more economically distributed than the bulky power-gas.

We have seen that the production of coal-gas and the coal used for domestic fuel amounts to another 50,000,000 tons, of which certainly 10,000,000 could be saved by the treatment of the bituminous coal at the gas works and the utilisation of the gas and low temperature coke for domestic use in the place of coal, whilst the products from the tar would effect other economies by providing large supplies of motor spirit and fuel oil. It certainly is no exaggeration to say that at least one-fourth of the present amount of coal raised could be saved, and at the same time our atmosphere freed from the intolerable curse of smoke.

* Better expressed as 8,200 British thermal units.

In considering the methods which can be employed to prolong our coal supplies, not only must the question of economy in use be borne in mind, but also how far it is possible to replace coal for the generation of heat and power by other materials; and I have already pointed out that peat, the intermediate product of the decomposition of vegetable fibre undergoing conversion into coal, is a fuel of considerable value. It is almost as widely distributed as coal itself, but the same careful determinations of the extent of the peat bogs have, of course, never been made, although a fair idea may be gained from the following approximation of the amount likely to be available:—

	Acres.
Sweden	12,840,000
Norway	3,952,000
Denmark	200,000
Finland	18,278,000
Russia (in Europe)	93,860,000
Great Britain	6,000,000
Germany	7,007,400

In these bogs the deposit of peat varies very much in thickness, but it is no uncommon thing to find it 14 to 16 feet deep.

This peat, which has been produced by the growth of different forms of marsh plants, varies considerably in its composition and qualities, the most valuable bogs being almost entirely produced by mossy growths of the genus sphagnum, which starts its growth in shallow pools, and continues growing at the top, whilst it dies off below, so that it gradually fills up the pool with a mass of vegetable matter undergoing checked decay, which in time assumes a peaty consistency, and produces the peat bog or deposit. In the lower portions of this, resting on the surface of the soil in which they grew, are found the fossilised remains of many forms of trees.

The use of peat as a fuel has been restricted to countries in which there has been little or no coal, and in Ireland, Scotland, and many Continental districts, the air-dried sods of peat, piled at the back of the villagers' cottages, have for centuries been the chief fuel supply.

The trouble which has always militated against the use of peat as a fuel is that, being of an excessively spongy nature, it contains an enormous amount of water. It is not at all unusual to find at the bottom of the bog 80 to 90 per cent. of moisture, whilst even the top layers will contain from 79 to over 80. The trouble has always been to find a method by which this large quantity of water could be eliminated in a sufficiently economical way to make the peat a fuel of sufficient value to compete with other solid fuels.

The water is so firmly held by the cell walls remaining from the vegetable growth, and also by its being in a condition of semi-combination with some of the organic compounds present, that it is impossible to remove it by such means as pressing or wringing, whilst, if it be dried by artificial heat, the amount of fuel used to evaporate the 80 or 90 per cent. of water is greater than the fuel value of the dry peat produced, and air-drying has therefore been the only method that was available.

Air-drying, however, necessitates a good deal of handling of material, space, and time, and as peat is highly hygroscopic, unless the atmospheric conditions are dry, it is impossible to reduce the amount of water by air-drying to much less than 50 per cent. under the humid conditions which exist in the districts where peat is found in this country.

On the Continent and in Canada it has been found economically possible, by air-drying down to the lowest attainable point and then briquetting the peat, to form a fuel which will hold its own well against the brown coal briquettes largely employed on the Continent. Many processes have been proposed for the briquetting, some of which show great promise. One of the best that I have personally experimented with is that proposed by Dr. Ekenberg. In his process the peat, as taken from the bog, is reduced to a homogeneous mass of pulp, which is treated under pressure at a temperature of from 150° to 180°C. In this way the walls of the cells in which the largest proportion of the water is contained, are caused to burst and liberate their contents, whilst the organic compounds holding water are coagulated, so that the bulk of the water can be mechanically wrung or pressed out. The dry pulp thus left is slightly warmed and moulded into briquettes, which have a superior calorific value to those made by other processes, whilst the small quantity of hydrocarbons of the nature of paraffins which the peat contains causes the fibres on hot compression to bind together into a hard mass having much the appearance of ebonite, and with a specific gravity of 1·28.

Peat briquettes have been made for some time in both Sweden and Canada. The process generally adopted is to air-dry the peat till it contains only some 50 per cent. of moisture, and then to disintegrate and dry the residue

by artificial heat down to from 15 to 20 per cent., when it is pulverised and moulded by the aid of heat into briquettes.

We have seen that in Great Britain there exist more than 6,000,000 acres of peat bog, 2,373,300 of which are in Ireland, whilst even in England a very large acreage exists in some cases in counties where the climatic conditions would be as valuable for air-drying to a workable degree as those found on the Continent.

At the present time there exists a question which is but little inferior to that of fuel in its importance and bearing upon the future. In its solution I think some of the peat deposits of this country will play a leading part, while at the same time yielding a very large supply of power.

One of the most important factors in all manurial treatment of ground for agriculture is nitrogen, which can only be fixed by the plant during its growth to a very limited extent, and upon which the growth of cereals in sufficient quantity to supply the demands of an increasing population is very largely dependent. It is only in certain forms that the nitrogen can be presented to the plant in such a way that it can be assimilated, and the salts of ammonium and nitrates have been the compounds universally used. The sources of these supplies are limited, and their consumption has grown with even greater rapidity than that of coal, so that whereas in 1880 only a quarter of a million tons were employed, during the last year a million and a-half tons were used.

The chief sources of this vast supply of nitrogenous material are the great nitrate beds in Chili at Tarapaca, and the more recently-discovered deposits of Antofagasta and Tocopilla, which supply nine-tenths of the nitrate used for top-dressing where backward growths have to be stimulated as rapidly as possible. The great drain upon these deposits, however, threatens their exhaustion, probably within the present century, and as no further deposits of sufficient size to prove profitable have been found elsewhere, the necessity for such nitrogenous stimulants to plant life has led to innumerable attempts to produce ammonium salts, such as ammonium sulphate. These, as we have seen, can be made from the ammonia recoverable from slack in processes of the Mond type. It is also one of the most paying residuals of the gas works.

In common slack nearly 1 per cent. of nitrogen is present, and by gasifying the slack at temperatures fitted to liberate the nitrogen as ammonia, from 65 to 90 lbs. of ammonium sulphate can be made per ton of slack gasified. This has been a great factor in cheapening the power-gas and also helping to supply the demand for sulphate, which is almost unlimited, and must increase as the sodium nitrate deposits get more and more depleted.

Peat, like slack, practically always contains a certain amount of nitrogen, which can be extracted from it as ammonia under the same conditions. In some cases the nitrogen in the peat exists in much greater quantities, some samples containing as much as 3 per cent., whilst in other bogs it may be less than 1.

It has been shown by Rigby, Frank, Caro, and others that directly the nitrogen of the peat gets above 1 per cent. a profitable business is to be made by gasifying the peat in a Mond producer of modified construction. Those made by Crossley Brothers answer excellently for the purpose, and differ from the complicated original Mond plant by containing only one tower and one set of pumps in place of the three towers in the old form of Mond plant. By this process they are able to use a liquor with only half a per cent. of free sulphuric acid for the absorption of the ammonia in place of the 3 to 4 per cent. of free sulphuric acid that was used with the old chequer-work tower.

In such a plant the peat burns perfectly well whilst still containing 50 to 60 per cent. of moisture, a degree of dryness which can be arrived at in most places by a short period of air-drying. With some samples of peat which I have analysed, containing a little over 2 per cent. of nitrogen, it is possible to obtain as much as 134 lbs. of ammonium sulphate per ton of dry peat gasified. As being able to use it with 50 per cent. of moisture still in it, reduces the cost to a minimum, a ton of ammonium sulphate can be made at an expenditure of about £5 10s., so that as the selling price is £11 10s., there is a large margin for profit. The demand being unlimited, the price is not likely to fall below this point. One ton of ammonium sulphate could be obtained from between 16 and 17 tons of dry peat.

The power-gas produced during this operation is quite as valuable as that made from slack in the nitrogen recovery plant, and the dry peat would yield about 80,000 cubic feet per ton, although with a peat containing 50 per cent. of moisture the yield of course would be proportionately less.

Where nitrogenous peat of this character

exists near to railway accommodation, it would make a valuable centre of industry, as the power produced from the gas could be made and sold for far less than water-power at Niagara.

It must be borne in mind that the municipal trading of our local authorities has resulted in most of the big towns in the country being burdened with such enormous loans for tramways and other local improvements that to realise the money necessary to pay the interest on them the rates and taxes have been raised to such a point that all manufacturers who can do so are searching for sites for new works in lower-rated agricultural districts. There not only do they escape from the enormous taxation, but also in many cases they get away from vexatious regulations as to building plans, size of shops, &c., which generally accompany the heavy taxation. For purposes where electric power is needed the utilisation of the peat bogs would yield a power infinitely cheaper than could be obtained by the old processes.

Beyond the possible economies which I have enumerated it is difficult to go without hampering the commerce of the country, and even though we could succeed in reducing our coal consumption by one-third, we are merely putting off the fatal day when, bankrupt in fuel, we shall have to devise some new method for the commercial generation of power and warmth.

It is useless to rely on oil as a fuel to replace coal, as not only are the supplies at the present time totally insufficient to do more than enable us to use oil for purposes for which its ease of application specially fits it, but we are further confronted by the fact that oil will probably have ceased to be available some time before our coal supplies are exhausted. It is already becoming manifest that the drain upon the oil-bearing districts of the world is rapidly depleting the supply, and, although statistics show an increased annual output of oil, yet this is obtained from an increase in the number of wells, and the old wells are rapidly drying up. Although new fields are from time to time being discovered, it is no use looking forward to oil for taking the place of coal.

In this country the amount of water-power which could be utilised is extremely small, and although Scotland and Ireland are not so badly off in this respect as England, yet the amount that could be safely reckoned on would, according to estimate, be only equal to 1,200,000 tons of coal per annum, whilst such sources of power as the tides and winds are so costly to harness as to make their use almost prohibitive, and in the fuelless future the world will probably have again to return to vegetation for a solution of the trouble.

In commencing this course of lectures I drew your attention to the wonderful natural cycle by which all living matter in the world was built up from the waste products of past generations, and showed you that it was during the growth of vegetation that the fixation of the energy from the sun, which we are now utilising in the form of fuel, took place, and made for us those enormous stores which during the past hundred years we have so ruthlessly squandered.

As far as our knowledge goes it is vegetation, and vegetation only, that has the power of storing sun energy in such a form that it can be reproduced and converted into power when we require it. The extent to which this action can take place is but limited. Helmholtz calculated that, of the energy exerted by the sun's rays on any area of growing vegetation, about one fifteen-hundredth is fixed in doing chemical work, but, small as this fraction is, it is an important asset in the future of the world.

It is quite clear that existing conditions would render impossible the conversion of vegetation into any of the forms of fuel to which we are accustomed, as apart from the fact that the vegetation which formed our coal measures grew under entirely abnormal conditions, the conversion of the cellulose into peat, lignite, and coal, is an operation that requires a combination of time, temperature, and pressure impossible now to attain, whilst, save to a very limited extent, timber even takes too long in its growth to be more than an insignificant adjunct.

After careful consideration of every possible method by which growing vegetation could be rapidly converted into available fuel for the generation of heat, we are forced to the conclusion that fermentation will be the only practical solution of the problem.

Although grain contains a larger proportion of starch than potatoes, the latter will always be the more economical source of alcohol for fuel, as the crop given per acre is much larger. For instance, an acre of land will yield about $12\frac{1}{2}$ cwt. of grain, equal to $8\frac{1}{3}$ cwt. of starch, but from the same ground you could get 125 cwt. of potatoes, yielding 22 cwt. of starch. A ton of potatoes yields from 25 to 28 gallons of absolute alcohol, or up to 30 gallons of 90 per cent. spirit.

The beetroot sugar industry has made great strides forward in France, and beetroot molasses is a cheaper source of alcohol than even potatoes, whilst still later experiments show that even wood sawdust can be made a generous source of alcohol. When the great demand for alcohol as a fuel arises, it will be found that vegetation in all its forms will, by proper treatment, yield to fermentation, and give us the means of regenerating the solar energy that caused its growth.

For years past, in both Germany and France, the importance of keeping labour on the land and preventing overcrowding in the cities, has led to the Governments of those countries doing all in their power to encourage the production of industrial alcohol. In Germany especially State aid has not been spared to develop agriculture in this particular direction; and when we desire to find the value of alcohol as a fuel, we find that our own meagre experiments are entirely overshadowed by the work which has been done on the Continent.

If we are to judge a fuel entirely by its calorific value, alcohol would prove itself but a poor substitute for the hydrocarbons derived from shale or petroleum; but, as we have seen, there is a factor more important than calorific value, and that is the ease with which calories can be converted into work, and the use of alcohol and petrol respectively in the internal combustion engine is as good an example of this as could be cited.

In comparing the relative values of petroleum spirit and alcohol, the first point that must be taken into consideration is their thermal value, and in doing this with alcohol it is only the methylated spirit which need be considered.

Taking samples of Pratt's motor spirit, having a specific gravity of ·722, as representing the petrol, determinations were made of its thermal value, with the following results:—

	Calories.		British Thermal Units.	
	Gross.	Net.	Gross.	Net.
(a)	11,514·6	10,818·6	20,726·3	19,473·5
(b)	11,146·9	10,624·9	20,064·4	19,124·8
(c)	11,174·4	10,742·4	20,113·9	19,336·3
Average	11,278·6	10,726·6	20,301·5	19,311·5

In the same way samples of methylated spirit gave:—

	Calories.		British Thermal Units.	
	Gross.	Net.	Gross.	Net.
(a)	6,491·5	6,011·5	11,684·7	10,820·7
(b)	6,089·0	5,489·0	10,960·0	9,880·2
(c)	6,285·0	5,805·0	11,313·0	10,449·0
Average	6,288·5	5,768·5	11,319·2	10,383·5

It is evident, therefore, that, weight for weight, alcohol has not much more than half the calorific value of the petrol, whilst by volume the heat of combustion of the vapours would stand to each other as follows:—

Petrol ..	50·8 calories per litre of vapour.
Alcohol..	12·9 ,, ,, ,,

So that if thermal value were the measure of the value of liquid and gaseous fuels in the internal combustion engine, alcohol would have a very poor chance of ever competing with petrol. There are many factors, however, which play an important part in determining the percentage of thermal value which can be converted into power, such as the degree of compression that can be employed without fear of premature ignition, the amount of air needed to complete combustion, the rate at which the vapour diffuses through the air creating a uniform mixture, the range over which the mixture is explosive, the possibility of keeping down the cylinder temperature, and other but little-studied points.

It so happens that nearly all these are in favour of alcohol, the use of which enables a higher compression, a cool cycle in the engine, the use of a moderate volume of air, and a greatly increased range of explosibility of the mixture of alcohol vapour and air, this resulting in making alcohol nearly as effective a fuel as petrol.

Experiments were made in Vienna at the time of the last Exhibition there upon two 8 horse-power engines, one designed for petrol and the other for alcohol, and the following results were obtained:—Petrol, 340 grams per brake horse-power hour; Alcohol, 373·5 grams per brake horse-power hour. The efficiency calculated for the petrol was 16·5 per cent., and for the alcohol 28 per cent., whilst M. Cheveau, working with a 16 horse-power motor, running at 1,800 revolutions, obtained with alcohol an efficiency of 38 per cent.

When a mixture of petrol vapour and air is made at atmospheric pressure and a light applied to the mixture, it will just burn when there is 1·25 per cent. of the vapour present, and the combustion increases in vigour until it reaches its maximum power with 2·5 per cent., and after that the explosion gets weaker with increase of vapour, until when there is 5·3 per cent. it is non-explosive.

When, however, electrical ignition is used the range is a little shortened, and it may be stated that the limits of explosion are from 2 per cent. to 5 per cent. With alcohol

vapour mixed with air the range over which the mixtures are explosive is much wider, and any percentage from 4 to 13·6 of alcohol vapour in air will explode. The value of this extra range must be manifest when one considers the difficulty of getting an exact mixture in the cylinder: indeed it would be practically impossible were it not for the fact that both compression and increase of temperature widen the range, and as in the cylinder before explosion compression gives a high temperature, both factors are at work, but the ratio of range for equal compression will probably remain much the same as at atmospheric pressure.

If a large alcohol industry were to become a necessity, as it undoubtedly will in the far future, large areas in England and Ireland, at present unremunerative, would be put under cultivation for potatoes, and whilst the pick of the crop was marketed, the remainder would be fermented. Under proper conditions the price of potatoes for this purpose would be reduced to 20s. a ton, whilst in Ireland now in a good season potatoes cost 35s. to 45s. per ton wholesale.

The reduction in cost of the raw material, however, is only one possible economy, and although the methylated spirit is called duty-free, the Government charges for denaturation and supervision amount to 5d. a gallon, whilst the cost of fermentation and distillation could be considerably reduced if the manufacturers had not to comply with Government requirements intended to facilitate supervision. It is a moderate computation to say that 90 per cent. methylated spirit of an undrinkable character could be easily made at well below 1s. a gallon if it were in reality duty-free. That this is so is proved by the fact that in Germany in 1903 the price of industrial alcohol was down to 9d. a gallon. It has risen since then as high as 1s. 3d. owing to a failure in the potato crop, but the good crops of the last two years again reduced the price.

In these lectures I have attempted to show the pressing necessity for facing at once the fact that, as far as fuel is concerned, we are living on our capital and squandering it in a way which not only ruins our atmosphere, but will shortly render it impossible for us to hold our position in the world. I have also tried to make it clear that, although it would be madness to do anything that would hamper our commerce, yet that is quite easy by adopting economies of the simplest kind to prolong the period during which it will be possible to obtain coal at a usable price. If these four lectures have helped in any way to attract attention to this all-important question, they will have justified the attempt to crowd an infinite amount of matter into four short hours.

IRRITANT WOODS.

In the course of the past year inquiry was made by the Factories and Workshops Department into the effect of irritant woods and the extent to which they are used in this country. For example, in the case of satin-wood, there was inquiry into (1) the extent and class of work in which it is used; (2) the evidence there is as to its irritant action on the skin; (3) the precautions taken in its use. Much confusion was found as to the kind of wood referred to as satin-wood—the two covering East and West Indian satin-wood and satin walnut. The first two are practically confined to high class furniture and furniture making, and to decoration of cabins and overmantel work in ships. Occasionally thermometer stands, backs of toilet brushes, and similar articles are made of it. In these trades it is used as an inlay or veneer involving little exposure to irritant dust. East Indian satin-wood possesses much more irritant properties than the West Indian variety. Satin walnut appears to be no more harmful than deal. The East Indian wood is only used in two shipyards. It causes an eruption on the skin of the worker exposed to the dust or shavings produced during manufacture, but some persons are much more susceptible to its effect than others. One man stated to the Inspector that if he only placed a shaving of the wood on the back of his hand it caused a sore on the skin at that point. The injurious effects, however, appear to be only temporary. Exhaust ventilation is in use for carrying off dust, &c., from the machines in most of the works, including one of the shipyards in which the East India wood is used. Reference to occasional contact action on the skin is made as to teak by Mr. Inspector Wright (North London), who refers to reports of "swollen arms and eyes," by Mr. Shannin (Liverpool), and by Mr. Grant (Preston) as to teak and olive wood. The Inspector in Sheffield states that: "In the manufacture of knife scales and tool handles the following woods are considered to be irritant—some of the ebonies, magenta rosewoods, West Indian box-wood, cocos-wood, and partridge-wood. Irritation of the eyes and nose is caused also by woods of the mahogany type. East Indian wood had to be discarded in the shuttle trade owing to its irritating action on the eyes. Mr. Lewis (Manchester) states that salica-wood from Cuba was stated to give off "a fluffy dust under the machines and hand planes, the effect of which upon the workers is to cause a running of the eyes and nose, and a general

feeling of cold in the head. The symptoms pass off in an hour or so after discontinuance of work." Eczematous eruptions are said to he produced by so-called Borneo rosewood, a wood used owing to its brilliant colour and exquisite grain in fret-saw work, but the Director of the Imperial Institute, Sir Wyndham Dunstan, who has interested himself in this wood, has failed to discover injurious properties in it.

WILD SILKWORMS IN MANCHURIA.

The wild silkworm of south-eastern Manchuria, commonly called by the Chinese, "Shan-ts'an," produces much of the silk used in the manufacture of pongees throughout China and Japan. According to the American Consul at Tsingtau, the industry has become a most profitable supplement to the agricultural work of the farmers, for practically all landowners whose boundaries include hilly ground make sericulture a part of the regular routine of their household. Although in many places the hills have not the necessary scrub oaks, on the leaves of which the worms feed, it has been demonstrated that these can be easily grown, so that with nearly perfect climate conditions there seems every likelihood of the industry expanding indefinitely to meet the increasing demand in many countries for both the silk and the pongee. This probability is also increased by the announcement of two recent inventions in Tokio, which should bring Tussah upon the market as a competitor with the domestic raw silks of China and Japan. The first is a new process for bleaching the silk, which will render it amenable to dyeing, and the second is a spinning machine which makes a smoother and more uniform thread than is now procurable. Conservative estimates place the silk-producing qualities of these cocoons at from $5\frac{1}{2}$ to 8 ounces avoirdupois from 1,000 spring cocoons, and the amount from the heavier autumn cocoons at from 8 to 12 ounces, and from the pierced cocoons about $5\frac{1}{3}$ ounces. The cocoons of different years yield different average amounts of silk, so that their market value depends upon two factors—the price of silk and the silk-producing qualities of the season's crop. With the cost of the raw material just covered by the returns from the silk spun, the filature owner looks to the by-product of waste silk, approximately equal in weight to the pure silk, to pay for the labour of spinning and to provide the profit. When just fresh from the trees, the autumn cocoon averages about $13\frac{1}{3}$ pounds per 1,000, while the cocoons in the spring, after the chrysalides have been killed and dried by exposure to the cold, do not exceed from 8 to 10 pounds. The pierced cocoons weigh about $2\frac{2}{3}$ pounds per 1,000. To prepare these cocoons for shipment, the countrymen put about 30,000 in a basket woven of willow twigs and shaped much like a hogshead, which are bought at prices ranging from two shillings and sixpence to five shillings. Although these vary in capacity and weight, the average is about 30,000 cocoons, weighing 400 pounds net in the autumn, and about 35,000 cocoons weighing about 330 pounds in the spring. Two or three of these baskets are placed on the Manchurian cart, and on arrival in the town the baskets are taken to the sheds of the Commission houses, where they are dumped and repacked. During 1907 the total number of such baskets leaving Antung, Manchuria, was about 26,000, with a total net weight of cocoons of over 10 million pounds. Of these, more than 23,000 baskets were destined for Chefoo, and the balance for Japan.

RAILWAY COMMUNICATION BETWEEN BURMA AND WESTERN CHINA.

The Government of Burma have recently had under consideration the question of developing the communications between Burma and Yunnan, and according to the *Indian Trade Journal*, the more southern of the two favourite routes, *i.e.*, that from Bhamo, *viâ* Tengyueh, to Talifu, has attracted considerably more trade of late years; an Imperial Chinese Customs House has been established at Tengyueh, which is 140 miles by road from Bhamo; a British Consul is also stationed there, and the Taotai of West Yunnan has moved his headquarters from Talifu to that town. A survey was made in 1905–6 for part of a line from Bhamo to Talifu, and the estimate for a light 2 ft. 6 in. gauge railway as far as Tengyueh is 128 lakhs of rupees. But from the latter town to Talifu (if not for the whole distance, a metre-gauge would be more suitable on account of the increased volume of trade and also because a metre-gauge railway is at present under construction between Yunnanfu and the French metre-gauge railway system at Tonkin and expected to be opened to traffic in 1910. The length of the line from Tengyueh to Talifu would be about 260 miles passing through an ancient highway of commerce traversed by Marco Polo in the thirteenth century and for many centuries in modern times by the Burmese mission which used to convey the tribute from the Kings of Burma to the Emperor of China. It is admittedly a most difficult route, no fewer than seven mountain chains and three large rivers, the Irrawaddy, Salwen, and Mekong having to be crossed. The question of the kind of power to be used in any forthcoming railway is very important, and, after detailed consideration the engineers have arrived at the conclusion that a steam-worked railway is financially preferable. The estimate for the Bhamo-Tengyueh section of the line on the metre-gauge is about 163 lakhs, while the entire length of the metre-gauge line from Bhamo to Talifu would be 385 miles and would cost 720 lakhs. It is estimated that it would pay a dividend of $2\frac{3}{4}$ per cent. immediately after opening as the line would pass through a very populous and flourishing country.

HOME INDUSTRIES.

"*Social Secretaries.*"—It is satisfactory to find that in connection with the employment of women and girls in factories efforts are being made to an increasing extent by some of the larger employers to adopt conditions of factory life rather more than is general to the needs of these classes of workers by introduction of lady superintendents and social secretaries. In reporting to the Chief Inspector of Factories Miss Martindale refers to an experiment of the kind, in a large mill she visited where 1,600 women and children are employed, to bring about a better state of things among the workers. Miss Martindale's advice was asked by the managing director of this mill regarding an appointment he was about to make in his works. He explained that he was of the opinion that a woman's influence in his mill was needed, and that he proposed to appoint a woman whose duty it would be to supervise the health conditions under which the work was carried on, namely, ventilation, temperature, humidity, cleanliness, &c.; to undertake also the registration of all Home-office requirements the passing of the children by the certifying surgeon, the supervision of dining-room and catering arrangements, and occasional visiting of cases of distress. The lady superintendent was appointed and since then much interesting work has been done. Besides the duties described above, cases arising under Sec. 61 are carefully watched by her, and a doctor has been appointed to attend the mill every week and give advice to the women. Arrangements have been made with the public baths in the neighbourhood to reserve them for a few hours on several afternoons in the week for the use of half-timers in the mill. In this way all the children will have a hot bath at short intervals. Meals for the children employed, a crêche, and clubs are all in contemplation, and will shortly be in working order. In another large factory Miss Martindale found a social secretary appointed with similar duties, and learnt from her that it was especially on questions of health that her advice was sought. She was able to give assistance, and in this way came into direct touch with the workers. In this factory the workers were given the opportunity of consulting each week a doctor and a dentist. Their eyesight, when they were first employed, was tested, and if the use of spectacles became necessary they were only given employment on condition that the spectacles were obtained, which were supplied at a reduced price. In many factories employers now realise the low standard of feeding which exists among the workers, and efforts are being made to provide wholesome food at such low prices that it is within the reach of all.

The Employment of Mothers.—Factory inspectors continue to find many cases of the employment of mothers too long before or too soon after the birth of a child. The manysidedness of the problem of regulating the employment of mothers in industry becomes ever clearer. Mere enforcement of the prohibition of such employment unaccompanied by benefit funds (coupled with some control over the wages of deserting fathers) in many cases necessarily inflicts increased suffering on the mothers, and, if fully enforceable, would, without such funds, be liable to introduce new evils. Even if the prohibition were made effectual by removing the word "knowingly" from Section 61 it would need for its effectual working some system of registration and medical certificate. There is no doubt, says Miss Paterson, in her report upon the subject, that the result of the extensive and increasing employment of married women has been to make the outlook of the girl more like that of the boy, towards a life of industrial work, with child-bearing as a recurring incident of it, but child-rearing and the making of a home as almost outside her purview. Even the abnormal woman, who likes the mill best, although that involves absence from home from 5.30 a.m. until 6.30 p.m., would be glad to stay at home a month, at least, after the birth of a child, were it possible by some system of national or trade insurance to provide a fund from which she could draw. Unfortunately it is just when she is least fit for work that she most requires money.

The Fencing of Machinery.—One of the subjects to be discussed at the annual meeting of the United Textile Factory Workers' Association is the crowding and incomplete fencing of machinery in cotton mills. In the majority of cotton mills there is room for a great deal of improvement in this direction which might be effected without serious increase of expense or loss of convenience. In many of the older mills the driving wheels attached to mule head-stocks are insufficiently protected, and even in newer mills the external pulleys of carding engines and of opening machines in blowing-rooms are either guarded inadequately or left altogether unprotected. In blowing-rooms, where the machinery revolves at very high speed, it is very necessary that all possible protection shall be provided. Under the stress of competition machinery is apt to be crowded in textile as in other classes of factories, and this involves additional hazard.

An India-rubber Exhibition.—The official opening of the International Rubber and Allied Trades Exhibition is fixed for the 21st September at the Horticultural-hall, in Vincent-square, Westminster, and it will remain open for a week. Sir Henry Blake, recently Governor of Ceylon, is the President, and the Vice-Presidents are well known as experts, publicists, scientists, and officials. There is an advisory committee of about 150, which will represent the experience and the hope of the world with reference to india-rubber, its growth, manufacture, and distribution. The Exhibition will be the first of its kind ever held in Europe, and should be welcomed by all rubber-producing countries. The classification adopted includes caoutchouc pure and simple, gutta-

percha, and other similar products. The immense area laid under contribution will be understood when mention is made of Ceylon, the Straits Settlements, the Federated Malay States, Java, South India, Borneo, Equatorial Africa, Mexico, Brazil, and the West Indies. Since the Ceylon Exhibition of 1906, which was a great success, and which, by the way, was also presided over by Sir Henry Blake, then Governor of the colony, many important inventions and improvements have been introduced.

Operatives' Wages.—The General Committee of the Master Spinners' Federation have taken the course recently suggested in these Notes. At the annual meeting of the Federation, the General Committee's recommendation of a five per cent. reduction in the operatives' wages was considered and approved, and the committee were instructed to take the necessary steps for dealing with it. They have written to the secretaries of the three Trade Unions concerned, asking that a joint meeting may be held to discuss the state of trade and the wages question. It seems a sensible suggestion that may be the means of avoiding conflict. The spinning trade is generally losing money at present, and it is not surprising that employers seek to reduce wages on the ground that the advances they have made during the last two or three years have been on the understanding that in the lean time, certain to come, and which has arrived, there should be a reduction. Naturally the workers will contest this position, and they may be expected to urge that the reduction is at least premature. Admittedly the employers have made large profits during the last two or three years, which have allowed of generous dividends, whilst big amounts have been carried to reserves, making them so strong that they will enable further substantial dividends to be paid. It is much to be wished that the discussion may lead to the devising of some general means of conciliation which may give a greater sense of peace and security to the industry.

The Harvest.—Until the Agricultural Returns are published next month no very precise opinion can be formed as to whether the area under wheat shows substantial expansion this year, but expert opinion is that it does not. Yet the conditions last autumn were favourable to increased cultivation, the market then being exceptionally buoyant, and the land in good working condition. It is thought that considerable areas of winter wheat had to be ploughed down and re-sown with some other crop in the spring owing to the failure of the plant. The harvest will not be an early one, only a few fields of winter oats and barley being, as yet, ready for cutting. The heavy rains of July did considerable damage to the corn crops, which in many places were laid flat, and it is to be feared that although many of the crops will partially regain an upright position, should the weather continue dry and bright, the market value of the corn will be permanently affected.

GENERAL NOTES.

International Literary and Artistic Association.—The thirtieth Congress of the Association Littéraire et Artistique Internationale will be held at Mayence from the 27th September to the 1st October next. The Association was founded in 1878 by Victor Hugo. The work of this Congress will be devoted to the consideration of the revision of the Convention of Berne, and specially of propositions to be submitted to the Diplomatic Conference of Berlin. Information respecting the Congress can be obtained from M. Jean Lobel, General Secretary, 117, Boulevard St. Germain, Paris.

Passenger Traffic between England and France.—The improvement reported last year regarding the passenger service from London to Paris, Southampton, and Havre, has been maintained. The number of passengers carried by this route in 1907 was 59,378, against 49,121 in 1906, and 42,239 in 1905. The cargo imported by the mail steamers was 2,700 tons. The cargo exported was about 90,000 tons and 78 horses, showing an increase of 27,000 tons in 1906. In his report on the trade of Havre, Mr. Consul Churchill gave statistics of the passenger service between French and English Channel ports in 1907, which show that the largest number of passengers from this country to France, went by the Folkestone to Boulogne route, and numbered altogether 178,711, as against 177,342 that went by the Dover-Calais route. The numbers that went from Newhaven to Dieppe amounted in all to no more than 107,489; whilst from Southampton to Havre there were only 22,894. The figures show a gradual increase for all the lines of 97,000 passengers during the year. The motor-cars, accompanied by passengers, increased from 2,655 to 3,131.

Glass Bottles.—The world's largest bottle factory is at Düsseldorf; and in his report on the trade of the district (Westphalia and the Rhenish Provinces), Mr. Consul Koening (No. 4059, Annual Series) gives some particulars of the company which is, conjointly with other German and Continental manufacturers, introducing the "Owen Patent Glass Bottle Machine." The latter will, says the Consul, revolutionise the manufacture of glass bottles in all the factories, and he expects that the art of blowing glass bottles by hand will have become extinct in about ten years' time. The export trade of the Düsseldorf glass works is very large. The Rhenish Westphalian Coal Syndicate was unable to supply the Düsseldorf glass factory with sufficient coal last year, and the Board of Directors were forced to import very considerable amounts of coal from the United Kingdom at enhanced prices. There is now a regular trade of coal from the United Kingdom, chiefly from Newcastle, up the Rhine to Düsseldorf.

Journal of the Royal Society of Arts

No. 2,908. VOL. LVI.

FRIDAY, AUGUST 14, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

SHAW LECTURES.

The Shaw Lectures on Industrial Hygiene delivered before the Royal Society of Arts in November and December, 1907, and February and March, 1908, by Dr. J. S. Haldane, F.R.S., Professor Thomas Oliver, M.D., William Burton, F.C.S., and Miss Nettie Adler have been reprinted from the *Journal* and issued as a pamphlet (price half-a-crown). Copies can be obtained on application to the Secretary, John Street, Adelphi, London, W.C.

THE EMPIRE OF THE HITTITES IN THE HISTORY OF ART.

By Sir George Birdwood.

"What wonder we that men should die? The statelie tombs do weare;
The verie stones consume to nought, with titles they bid beare."

Richard Knolles,
The Generall Historie of the Turkes, 1604.*

Although the Hittites are known to us as a political power only through the contemporary chronicles of the campaigns undertaken against them by the kings of Egypt and Assyria, they occupy an independent position of exceptional importance in connection with the development of the archaic civilization of Asia and Europe; for they were not merely the originators of the ideograms from which the syllabaries of Cyprus and Cilicia, and Mysia, and the non-Hellenic letters of the alphabets of Cappadocia, Lycia, and Caria were derived, but, if we may rely on the evidence of the Syrian, Rouman, and Anatolian sculptures ascribed to them, they were also the actual propagandists, in the course of their conquests and commerce, of the mythology, worship, manners, and customs, and characteristic illustrative arts, which, as influenced in their inception by the ubiquitous presence of Egypt, they received directly from Mesopotamia, and in turn transmitted, with gradual and continuous local qualification, eastward into Media and Central Asia, and westward, through Lydia and Ionia, to the islands and mainland of Greece; where they were introduced concurrently with the elements of Pharaonic culture directly imported from the delta of the Nile by the Phœnicians.

The Hittites were, in short, the immediate inheritors, long anterior to the subjugation of Babylonia by Assyria, of the civilization of the Chaldæan kingdom of "Father Orchamus," and Sargon [I.], and Hammarubi; and the first to disseminate it from "the river of Egypt" to the Black Sea, and from the Caspian Sea to the river Halys, and onward to the Mediterranean Sea, over all Syria and Asia Minor: it being assumed that the Hittites [*ha-Khitti*, and *Khittim*, and *bene-Khetha*] of the Old Testament are one and the same people with the *Kheta* of the Egyptian monuments, and the *Khatti* of the Assyrian inscriptions.

The *Kheta* of the wall paintings of the Ramesseum at Karnak, and on the great temple of Abu-Simbel, are certainly none other than the proto-Armenian defenders of Van figured on the bronze gates, now in the British Museum, of the palace of Shalmaneser II., at Balawat, who are the *Khatti* of the cuneiform inscriptions; and both are indistinguishable in their features, costumes, and military equipment, from the people autoglyphically portrayed on the sculptures attributed by Professor Sayce and Dr. W. Wright to the Hittites; and as the definition of "the land of the Hittites" in Joshua i. 4 exactly limits the country of the *Kheta* as known to

* Quoted in, "From Pharoah to Fellah," by Charles F. Moberly Bell.

the Egyptians, and the country of the *Khatti* as known to the Assyrians, it is unreasonable any longer to question the absolute identity of the *Kheta*, *Khatti*, and *Khittim* or Hittites.

The prolonged resistance they opposed to the ever-victorious armies of Egypt and Assyria proves the amplitude and solidity of the natural resources of their still shadowy empire, while their sculptures, situated in so many far-separated regions, show how wide was its extent.

They would appear to have been an essentially Turanian people, who perhaps gradually became partially Semiticized, and even in some degree Aryanized, They were originally a Northern people, as their shoes, with the toes turned up, indicate; but it was on the south side of the Caucasus mountains, before Media and Armenia were occupied by their later Aryan inhabitants, that they developed their distinctive nationality, and from Cappadocia enlarged their empire southward, across Mount Taurus, to Egypt, and westward to the shores of the Propontic and Ægean seas. They are the people whom the Greeks called "Leuco-Syrians," to distinguish them from ths darker Semitic populations south of Mount Taurus; and again they are identified by Mr. Gladstone with the Ceteans of the eleventh book of the Odyssey—

> "And round him [Eurypylus] bled his bold
> Cetean train;"—

who although classed with the Leleges and Caucones as forgotten, if not fabulous, races of the Homeric world, were in all probability a tribe of Hittites that had given their name to the river Ceteus [*Bergama-Chai*] in Mysia. We have probably a trace of them also in the name of the town of Citium in Thrace, for in the First Book of Maccabees, Macedonia is designated as the land of Chettium [i. 1], and the Macedonians as Citium [viii. 5]. Citium in Cyprus was undoubtedly a city of the Phœnicians, who from it expanded the denomination of Chittim to the whole island of Cyprus, and to all the islands collectively of the Ægean Sea. Hence it is applied in the Old Testament [Genesis x. 4 and 1 Chronicles i. 7] to the third son of Javan, as the eponym of the Aryan tribes [Dorians, Æolians, and Ionians] who succeeded the Phœnicians in the colonization and commerce of the Grecian Archipelago. But the Phœnicians, who formed a geographical link between the Aryan [Japhetic] Greeks, the descendants of Kittim, the third son of Javan, and the Semiticized Turanian *Khittim* or Hittites, the descendants of Heth, the second son of Canaan, if they were not ethnologically connected, through their Canaanitish predecessors in Phœnicia, the Sidonians, with the Hittites, must at least have appropriated the appellation of Chittim from the latter; and wherever it occurs, and under whatever disguises, we are justified in assuming, in the absence of sufficient arguments to the contrary, that it refers ultimately to the formidable Hittites, who between the twenty-fourth and eighth centuries B.C. established their military domination over all Asia Minor, from Syria to Lydia and Ionia.

It was in the seventeenth century B.C. that Thothmes I. began "the war of revenge" against the *Kheta*; thenceforth carried on by successive Pharaohs for nearly five hundred years. Thothmes III. defeated them before Megiddo [Armageddon of New Testament], and at Kadesh on the Orontes, and Carchemish on the Euphrates; and twice stormed the last-named city and reduced it to ashes. The sanguinary struggle was continued by the immediately following Pharaohs, but with such indecisive results that, about one hundred and fifty years after the death of Thothmes III., a treaty was concluded between his successor, Ramses I. and the king of the *Kheta*, securing, for a time, peace between Syria and Egypt. When, however, Seti I. came to the throne of Thebes, *circa* B.C. 1366, finding that the *Kheta* and their allies had recommenced their incursions into territories of Egypt, he at once attacked them, defeating them at "Kanaan," near the Dead Sea, and again at "Jamnia" in Phœnicia, where he overthrew with great slaughter "the king of the land of Phœnicia," and then marched against Kadesh, expressly as "the avenger of broken treaties," and captured the city by surprise. His son, Ramses II., who adorned the temples at Karnak, Abu-Simbel, Abydos, and Luxor, with the pictorial records of his father's and his own achievements, prosecuted his campaigns against the *Kheta* with such success, that at last "the great king of the *Kheta*" was compelled to submit himself; and a peace was settled between them that lasted sixty years; a circumstance probably due to the happy marriage of the Egyptian victor with the beautiful daughter of the vanquished *Kheta* king. More than two hundred years later, the *Kheta* are found among the federated invaders from Anterior Asia and Northern Africa, who were defeated by Ramses III. in the great

naval engagement at Migdol, the "Watch-city" at the Pelusaic mouth of the Nile; and thenceforward their dreaded name disappears from the history of Egypt.

In the inscribed tablets from the library of Assurbanipal [Sardanapalus], copied by that king from the original tablets of the library founded by Sargon [I.] at Agane, the *Khatti* are mentioned as continually assailing the kingdom of Chaldæa during the reign of the latter sovereign. He was able to drive them for a time beyond Mount Amanus; but no sooner did the Elamites begin to ravage Chaldæa, than the *Khatti* at once re-established themselves on the Orontes and Euphrates. Again, although the Egyptians frequently forced them to withdrawn into Cappadocia, the cradle of their empire, on the decline of the Theban monarchy, after the death of Ramses III., they promptly reasserted their dominion over Syria, and sustained it with the greatest vigour, until their final overthrow by the Assyrians in the eighth century B.C. They were indeed, with short periods of depression, the paramount power in Syria and in Asia Minor, from about the twentieth to the twelfth century B.C.

From the inscription of Tiglath-Pileser I. [B.C. 1120-1100] found at Kileh Shergat [Asshur], the oldest original Assyrian text that has hitherto been discovered, we learn that immediately on his coming to the throne he began to beat back the *Khatti* from the western borders of his kingdom; and that after a series of expeditions against them, he succeeded at last in temporarily freeing his frontiers from them. Assur-nazir-pal [B.C. 885-860] carried the arms of Assyria as far as the "Lebanon" and "the great sea of the Phœnicians," and exacted tribute from Carchemish and Gaza, "and other towns of the *Khatti*," and from Tyre, Sidon, Gebal, and Arvad. His son, Shalmaneser II. [B.C. 860-825], according to the inscription on "the Black Obelisk," led several punitive campaigns against the *Khatti*, and captured Carchemish. One hundred years later we find them still in deadly conflict with the Assyrians. But at last the empire of the *Khatti* was brought to an end by Sargon [II.], who in B.C. 717 fell suddenly upon Carchemish with an overwhelming force, and plundered it, and levelled it to the ground; and in subsequent campaigns brought the whole country of the *Khatti* to the Phœnician coast, and, north of Mount Taurus, to the Halys, under his sway. Henceforth the Hittites were known in Syria only as isolated tribes; while in Asia Minor their very name appears to have at once died out of the memories of the nations that inherited their institutions, and arts and industries, and their indefinite fame.

Their remains consist almost exclusively of inscriptions and sculptures distributed over the whole of north-western Anterior Asia. In Syria inscriptions have been found near Damascus, and at Hamah [Hamath], and at Aleppo. Several inscriptions, now in the British Museum, were found by the late Mr. George Smith at Jerabis or Jerablus [Carchemish], one of them being graven on the back of the mutilated bas-relief figure of a man. The so-called "Monolith of a King," now in the British Museum, was discovered about fifty years ago by the Rev. George Percy Badger, built into the wall of the Turkish Castle at *Birejik*, on the Euphrates. In the mountains dividing the plain of "Hollow Syria" from the uplands of Asia Minor, are the sculptures representing a hunting scene, chiselled with great spirit, on the rocks of the *Bagtche*-pass through the *Ghiaour-Dag* [Mount Amanus]; the inscription on the Assyrian lion* on the Turkish Castle at Marash, at the southern foot of the *Bulghar-Dag* [Mount Taurus]; and the inscription in a curious gorge near *Ghurun*, at the northern foot of the *Bulghar-Dag*.

We are now among the elevated pasture-lands and vineyards and wheat-fields of Asia Minor; and it is here in the Turkish provinces representing the ancient Cappadocia, Lycaonia, Pontus, Galatia, Phrygia, and Lydia, that the Hittite monuments of the greatest interest exist. Just within the limits of the Turkish province of Koniyeh [Lycaonia] and north of the *Kulek-Boghaz*, or "Ciliciæ Pylæ," at *Ibreez*, near *Eregli*, the ancient Heraclea, are the remarkable sculptures representing a man, clad in the usual Hittite costume, worshipping the local god of corn and wine. The long robe wrapped round the former is richly broidered and fringed, and diapered all over with the simple but effective geometrical designs still to be seen in the domestic fabrics woven by the hardy peasantry of Koniyeh, Roum, and Armenia, and throughout Central Asia. The robe is worn very much in the Hindu fashion of Western India; and the whole figure of a man, with his weighty necklace, "tip-tilted Hittite boots," and twisted head-gear, strongly resembles that of some

* It is now, I believe, with the Hamah stones, in the Imperial Museum at Constantinople.

wealthy merchant of Guzerat in the attitude of devotion before an exalted image of the Lord Preserver, Vishnu. There is an inscription at *Bor*, between *Eregli* and *Nidgeh*, and another at *Kilesseh-Hissar* [Tyana], close by *Bor*, and at *Iflatum-Bunias*, near to the *Beishehr* lake, in the southern corner of Koniyeh; and there are traces of Hittite art on two small slabs found at Kaissariyeh [Cæsareia, more anciently Mazaca], in Central Koniyeh [Cappadocia], but known to have been originally brought from Amasia, in Roum. At *Boghaz-Keui* [Pteria] in North-western Roum [Galatian Cappadocia], the reputed site of the Hittite capital of Asia Minor, are the dilapidated remains of a building, arranged on the same ground plan as the palaces of Chaldæa and Assyria, but raised on a terrace of Cyclopean masonry, instead of on a mound of burnt-clay bricks; and near it are the ruins of a temple, sculptured within with the figures of the Hittite gods, advancing in procession, from the right hand and the left, until they meet face to face in the centre of the side of the open rock-cut court opposite the entrance. All the gods stand, after the manner of the gods of the Hindus, on their symbolical vehicles [*vahans*]; the right-hand procession being headed by Rhea-Cybele [Nana-Ishtar, Ma], borne on a lion, and wearing her turreted diadem; and the left by the beloved Attys [Bel, Baal, Papas, Tammuz, Adonis]. Two smaller figures behind the great goddess are represented standing on the Hittite "double-headed" "spread-eagle." At *Eyuk*, a little to the north of *Boghaz-Keui*, there is another Hittite palace with Sphinxes, of the standing and affronted Assyrian type, carved on one of the gateways; and outside this gateway there are reliefs portraying a number of persons worshipping before an altar, and also a snake charmer playing on a guitar [*vina* of Hindus] to the serpent coiled round his body, while another man stands beside him holding a long-tailed monkey by the hand; a group exceeding Indian in its composition and physiognomy and movement. Several other animals are also represented, the fanciful double-headed eagle again being prominent among them. This device reappears also among the golden ornaments found by Schliemann at Mycenæ; and then is lost sight of in Asia Minor for nearly two thousand years, when it was revived in the twelfth and thirteenth centuries A.D. on the coins of the Seljuk Turks; and was introduced by the Counts of Flanders into Europe in the twelfth and thirteenth centuries A.D. Professor Sayce believes it to have been originally a form of the conventional winged thunderbolt of Bel Merodach. Its plastic prototype was the "spread eagle" borne as a military standard and symbol of victory, by the conquering hero of the reliefs on the funeral stele of white stone found by M. de Sarzec at *Tel-Ho* in Chaldæa.

At *Ghiaour-Kalessi*, near the villages of *Kara-Omerlu* and *Hoiadja*, nine hours south-west of Angora, the ancient Ancyra, in Eastern Anatolia [Galatian Phrygia], are two colossal figures of Hittite warriors, hewn in the face of the mountain rock, supporting the walls of a Cyclopean fortress, erected by the Hittites on this site for the transparent purpose of commanding the ancient high road between Pteria and Sardis. They are the counterpart of the two colossal figures of warriors cut on the rocks overhanging the ancient road between Phocœa and Smyrna, and Ephesus, where, after doubling the eastern shoulder of Mount Sipylus, it is joined near the village of *Karabel* by the road from Sardis. These latter figures have been supposed, from the time of Herodotus, to represent the renowned legendary Sesostris [Seti I. and his son Ramses II.]; but Professor Sayce has been able to demonstrate, from the inscription still legible on one of the figures, that they are the work of the Hittites. The famous seated figure, carved in full relief out of the living rock, on the northern slope of Mount Sipylus, four or five miles from the ancient Magnesia, and alluded to by Homer [Iliad xxiv. 602-20], and Sophocles [Antigone 816-22], and described by Pausanias [Attica xxi. 5], as "the weeping Niobe," has also been shown by Sayce to be a Hittite statue of Rhea-Cybele, to the worship of whom, as "Mater Sipylina," the city of Smyrna was devoted.

A duplicate of this profoundly interesting statue has been recently discovered by (W. M.) Ramsay at *Sidi-Gazi* [Nacolea], between *Kutaya* [Cotyæum], and *Bala-Hisar* [Pessinus, in the very heart of Anatolia [Phrygia], in the immediate vicinity of Pessinus, and among the defiles of Mount Dindymum, it may be identified with Rhea-Cybele as Dindymene and "Mater Pessinuntia."

In the neighbourhood of the latter statue, close to the modern village of *Ayazeen*, Mr. Murray found a rock-cut tomb, flanked at its entrance by two rampant lions, affronted before a phallic pillar* rising up between them

* I believe that these pillars must have supported a solar disc like the Buddhistic "wheel."

from the top of the doorway on which their forepaws rest. The sepulchre proved to be the earlier of eight, decorated with the same symbolical subject, and all belonging to an age subsequent to that of the acknowledged Hittite sculptures, but anterior to that of the similar lion group, "the device of the Pelopidæ," above the gate of the Acropolis of Mycenæ, now proved by Mr. Ramsay's discovery to have been introduced into Greece from Phrygia. Close to *Sidi-Gazi* and *Doganlu*, at the village of *Yazil-Kia*, *i.e.*, "the Writing on the Rock," is the so-called "Tomb of Midas;" the type of several similar caverned sepulchres, with façades carved all over with simple geometrical patterns identical with those used in the ornamentation of modern Turkoman carpets; and obviously intended to represent curtains, similar to those hung before their tents at the present day by the Turanian nomads of Asia Minor, Persia, and Central Asia. These tombs are thought to be the latest examples of Phrygian art, as those at *Ayazeen* are supposed to be the earliest.

The Hittites were apparently still at the height of their power when, in the tenth and ninth centuries B.C., Asia Minor was overrun by recurrent hordes of Thracian Aryas [Pelasgian Bryges], and this protracted assault on the centre of their empire no doubt served to render their destruction final on the capture of Carchemish by Sargon [II.]. But this renewed Aryan invasion of Asia Minor would seem to have given a great impetus to the development of the Phrygian, or, as it might be styled, Aryanized Hittite kingdom that was now established on the Sangarius, and continued, in succession to the Hittite kingdom on the Halys, to dominate all the countries between the Euxine and the Mediterranean seas, until it succumbed to the attacks of the mixed Aryan and Turanian barbarians, known in history as the Cimmerians, by whom Asia Minor was invaded in the eighth and seventh centuries B.C., when Phrygia, on the death of its last king Midas, became absorbed in the Mæonian kingdom of Lydia; which in its turn ruled over Asia Minor, until Crœsus, the son of Alyattes, and the last of the great dynasts of the Mermnadæ, was subjugated by Cyrus, B.C. 554. It is to the comparatively late period of the Mermnadæ [B.C. 724-554] that "the Tomb of Midas," and the other Phrygian tombs at *Doganlu* probably belong. But if the sculptures at *Boghaz-Keui*, *Eyuk*, *Ghiaour-Kalessi*, *Karabel*, and *Sidi-Gazi*, are the latest that can be classed as their actual handiwork, the indirect influence of the Hittites as the first civilizers of Asia Minor is still to be traced in the so-called "Grave of Tantalus" on Mount Sipylus, and the so-called "Monument of Alyattes" at Sardis, the former one of twelve, and the latter of a hundred graves of similar character, all probably belonging to the age of Crœsus, and copied apparently from the heroic tumuli of the Troad, known as the "Tomb of Achilles," the "Tomb of Priam," &c., all identical in form and structure with the numerous Hittite burial mounds of the plain of "Hollow Syria," between the Orontes and the Euphrates.

Beside the monuments above enumerated, several other minor objects of Hittite art have been discovered, such as the stele, and a stone bowl with a Hittite inscription round its outer surface, both found at Babylon; the circular seal of black hematite, now in the British Museum, found at *Yuzgat*, near *Boghaz-Keui;* the cubical seal of hematite, belonging to Mr. Greville Chester, found near Tarsus; the eight seals found by Layard in the "Record Room" of the palace of Sennacherib at *Koyunjik* [Nineveh]; the eighteen seals, belonging to Mr. Schulemberg, "found in Asia Minor;" and lastly, the silver boss, offered in sale about twenty-five years ago to the British Museum and elsewhere, but refused in the belief that it was a forgery, and since disapparent. Fortunately, an electrotype of it was taken at the British Museum, and a cast by Mr. F. Lenormant; and these have enabled Professor Sayce to determine that the incription on the boss was what is called bilingual, or written in two characters, cuneiform and Hittite, and read: Tarik-timme [compare with Tarkondemos of Plutarch], King of the country of Erme [compare with Urume of the inscriptions of Tiglath-Peleser I.]." It is the only Hittite bilingual inscription yet brought to light, and, unhappily, it is too short to be of any great practical use of itself, and the longer Hittite inscriptions consequently still remain undeciphered.

But, notwithstanding that we have not yet succeeded in expounding the dark secrets of the Hittite inscriptions, they, and the sculptures illustrating so many of them, reveal to us a uniform system of ideographic writing, and a self-consistent style of art, founded indeed on that of Chaldæa, and not uninfluenced by that of Egypt, but stamped with its own strongly-impressed ethnical and local cha-

racteristics, and visibly pointing to a homogeneous and universal, if invisible empire in Hollow Syria and Asia Minor that can be none other than that of the *Kheta*, *Khatti*, or Hittites. Their inscrutable inscriptions, and their unambiguous and peculiar sculptures, exhibiting such strange religious symbols as "the mural crown," and "the double-headed eagle," everywhere in association with the same decorative patterns,—the chevron, meander, square, cross [*swastika*], and anthemion [lotus],—and with the same fashion of dress and military armament—"the tip-tilted boot," "the high-peaked turban," the short, high-girded sword, the long spear, and round shield, and bow and arrow:—all these tangible, singular, and significant vestiges of an extinct, indigenous civilization, at once indeed testify to the reality of "the Empire of the Hittites," and to the all-important part played by it in the development of the primitive, and, as regards Europe, the pre-historic culture of the Old World.

Until the eighth century B.C. the Hittites were the most powerful people in Syria and Asia Minor, and the main intermediaries through whom the arts of Chaldæa and Babylonia were transmitted to the shores of the Euxine, Propontic, and Ægean seas; and after the annihilation of the Hittite nationality by Sargon [II.] although the modified Babylonian Arts of Assyria were chiefly exported from Mesopotamia by sea, and in the course of the coasting trade between Phœnicia and Hellas, served to exert a specific influence on the proto-Ionic art of Lycia, Caria, Lydia, and Mysia, they continued also to find their way westward by the immemorial overland routes through Cappadocia, Phrygia, and Lydia; so that it is almost impossible to set bounds, either in geographical area, or in historic time, to the influence of the Hittites on the arts of the Old World.

The art of Greece, in its earlier prehistoric examples, antecedent to the twelfth century B.C., was exclusively derived from Chaldæa and Babylonia, through the Hittites; and in its later prehistoric period, between the twelfth and eighth centuries, although Greece was at this time in communication, through the Phœnicians, with both Egypt and Mesopotamia, it continued to be predominantly influenced, through the intervention of the Hittites, by that of Mesopotamia, then centered in Assyria. Even after the disappearance of the Hittites, the authority of Assyria was exercised over Greek art all through its archaic period, from the eighth to the fifth centuries B.C., not so much in the course of the commercial navigation of the seafaring Phœnicians, as along the Hittite military road from Carchemish to Sardis, and Smyrna, Ephesus, and Miletus; for it was by this overland route across Asia Minor that the proto-Ionic column, and all the arts correlated with the Ionic order, were carried from Assyria into Greece. When, moreover, the Ionian States were, for a while, during the rise of the Lydian Kingdom under the Mermnadæ, cut off from direct communication with the interior of Asia Minor, the immemorial intercourse between Greece and Mesopotamia was, notwithstanding this temporary obstruction, maintained by way of Sinope, and the other Milesian colonies, founded in the eighth and seventh centuries B.C. on the Asiatic shores of the Euxine sea.

During the fifth and fourth centuries B.C., Hellenic art completely emancipated itself from foreign exemplars, and then, in the suite of "striding Alexander" and his successors, and of the "full-fortuned Cæsars," it began to react on Asia Minor, and Egypt, and Syria, and Mesopotamia; the Hellenization of these effete Semitic and Semiticized nations going on uninterruptedly to the commencement of the attacks of the Goths, and Vandals, and Huns, and, after them, of the Arabs, and Turks, and Mongols, on the western and eastern provinces of the Roman Empire. This refluent revivification of Asia by Europe was naturally first and most felicitously felt in the primeval Hittite lands opposite Hellas, the coasts of which had been colonised from the eleventh century B.C. by the Æolian and the Ionian Greeks; and it was in Ionia, where, as also in Lycia, there had been something like an independent growth of Hellenic art, parallel with its development in Crete, Argos, Sicyon, Ægina, and Athens, that some of its noblest fruits were matured, on, as it were, its true native soil, and from roots originally transplanted from Mesopotamia by the Hittites.

We have thus preserved to us in Asia Minor illustrations of the art of Greece at every stage of its evolution; from the rough-hewn bas-reliefs of alien workmanship that, when as yet it was not, were the earliest models of its lowly imitative beginnings, to the masterpieces of free and spontaneous expression in architecture and statuary, that bear still living witness to its unapproachable perfection in the age of Pericles; and also the debased and grandiose monuments of its gradual decline and degradation during its servitude to Imperial Rome.

First, there are the vestiges, extending over the sixteen centuries, from B.C. 2400 to B.C. 800, of the primitive Chaldæan art of the Hittites, that was the immediate inspiration of the pre-historic or pre-Homeric art of Greece, as exemplified by the tombs of Spata and Menedi in Attica, of Orchomenos in Bœotia, and of Nauplia and Mycenæ in Argolis; by the Cyclopean masonry of "walled Tiryns" and of Mycenæ; and, above all, by "the Lion Gate of Mycenæ." To the later centuries of this prolonged period belong the remains found at *Ayazeen* of the dubious art of the Phrygians. During these later centuries also, the artistic manufactures of Egypt and Assyria began to be imported by the Phœnicians into the southern and western coasts of Asia Minor and the neighbouring islands of the Grecian Archipelago; and the kermes red, saffron yellow, and indigo blue garments, and rich embroideries, the jewellery, and bronze vessels, and arms and armour, and furniture,

"Made all of Hebon and white Yvorie,"

received overland across Asia Minor, and by sea from Sidon, being imitated with ever-increasing skill by the Greeks of Dorian Crete, Rhodes, Thera, and Melos, and of "suddenly uprising Delos," the centre of the Ionian Cyclades, and the most sacred seat of the Pan-Hellenic worship of Apollo, there gradually rose among them the mixed Egyptian, Mesopotamian, and indigenous insular art, intermediate in character between the pre-historic and the archaic art of Greece, and distinguished as Pelasgian. This phase of Greek art is illustrated by the mass of the "Sidonia wares" found by Schliemann at Mycenæ and Troy, and by the so-called "Island Stones," or ovoid, cubical, and prismatic seals of steatite, sard, agate, jasper, and chalcedony, engraved with an unpremeditated originality and spontaneous sense of beauty that are the sure foretokens of the supreme excellency in the higher representative arts subsequently attained by the Greeks.

Next in order are the remains in Asia Minor of the archaic period of Greek art, arbitrarily reckoned from B.C. 776, the date of the first Olympiad, to B.C. 486-79, the date of the close of the Persian wars with the decisive Greek victories of Salamis and Platæa. During these 300 years, the artistic influence of Assyria was still predominant in Asia Minor and in insular and continental Greece, and gradually led to the development of the proto-Ionic building style, most of the examples of which, in Asia Minor, its native country, disappeared during the destructive progress of the campaigns of Cyrus, and of Darius and Xerxes [B.C. 546-480-79]; excepting in the mountainous and comparatively secluded district of Lycia, where some of the monumental tombs erected before these campaigns, survived them unharmed, or were at least restored without any change in their construction and ornamentation; and have thus preserved to the present time the true type of the crudely compiled Assyro-Aryan art of the period. The so-called "Harpy Tomb," at Xanthus, is one of the earliest of these Lycian monuments; but the later rock cut sepulchres at Telmissus, Antiphellus, and Myra, and the similar structures at Caryanda, Pinara, and Limyra, none of them probably dating before the third and fourth centuries, B.C., as faithfully reflect the architecture of the wooden houses, in which the Aryan Lycians dwelt in the first century of the archaic or proto-Ionic period of Greek art. The so-called "Tomb of the Rock" at Myra may be particularly instanced, on account of the marked Assyrian character of its decorative details. The same foreign features are to be clearly traced in the more advanced Ionic art of the so-called "Monument of the Nereids" at Xanthus, and the Heroon at *Djolbashi*.

It was during this transitionary period of Greek art that the vast Ionic temples, the ruins of the restorations of which after the Persian wars are still to be seen at Branchidæ, Samos, and Ephesus, were first built of marble, in the place of the timber temples that had previously occupied the same sites. It was then also that "glorious" statues [ἀγαλματα] of marble were substituted for the "scraped" wooden images [ξοανα] of the gods; and these noble transformations were all initiated by the Ionians, who, at the beginning of the sixth century B.C., were the leading people among the Greeks in all the arts that minister to the dignity and refinement spirituality of civilized life.

The artistic influence of Assyria during this period moreover extended far beyond Asia Minor and Greece. It had become predominant in Egypt from the tenth century B.C.; and about the same date it must have begun to prevail in Italy; for when Rome was founded in the eighth century, Etruria, or archaic Rome, already possessed its own peculiar national arts, the sources of which must be sought not only in Egypt and Greece, but directly in Assyria. The Etruscans were not actually,

or not altogether Phœnicians, like their intimate allies the Carthagenians, but they received the arts of the East through the Phœnicians, and transmitted them, as modified in passing through their own hands to the Romans. The Æolian Greeks of Cyme in Asia Minor who, with the Æolian Greeks of Chalcis in Eubœa, founded Cumæ, the oldest of the Hellenic colonies in Italy in the eleventh century B.C., and the Ionian Greeks from Abydos and Naxos, and the Dorian Greeks of Corinth, Megara, Crete, and Rhodes, who settled in Sicily in the eighth century B.C., also carried with them the same Eastern arts as they practised in Greece, where they had been originally introduced through the Hittites and the Phœnicians, and again adapted them to the local conditions and necessities, and the newly developed manners and customs of their larger colonial life in "Magna Græcia." The Romans, in their turn, in rising to importance in Italy, borrowed the circular Assyrian arch from the Etruscans, the same arch as has been found among the ruins of the Phœnician substratum of the temple of Solomon [*circa* B.C. 1015-980] at Jerusalem, and the Egyptian stone lintel from the Campanian Greeks, as also the general plan, construction, and ornamentation of their temples, and domestic dwellings; and the mixed Etruscan and Italiote elements thus combined in the national architecture, rnn through all the minor arts of republican Rome; and when Greece became a province of the empire [B.C. 146], and Greek architects and sculptors and painters, who had long ceased to depend on Asiatic incentives for their inspiration, were reduced to the humiliation of having to labour for the gratification of the ostentatious tastes of their proud conquerors, the extended application they gave to the round Assyrian arch of Etruria determined the type of the enslaved Greek art of Imperial Rome, as exemplified by the vast basilicas [town halls, literally, στοά βασίλειος], and the baths and amphitheatres erected under the Cæsars in every capital city of their world-wide dominions, and by the august Pantheon of Agrippa, and other similarly constructed temples, the lofty domes of of which became the distinctive feature of the churches of Christianized Italy.

The period of the greatest splendour of the arts of Greece, from B.C. 480, the date of the deliverance of the country from the Persians, to B.C. 146, the date of its subjugation by the Romans, signalized by the successive supremacies of Athens, Sparta, and Thebes [B.C. 480-338], the astonishing conquests of Alexander and the Diadochi [B.C. 338-280], and the brilliant reign of the Attalidæ at Pergamum [B.C. 280-133], is marked in Asia Minor by the restored temple of Artemis at Ephesus, and of Here at Samos, the two largest and most magnificent of Greek temples; by the temple of Apollo at Branchidæ; and of Artemis Leucophryne at Magnesia, the most harmonious and beautiful in its proportions of all Ionic temples; by the temple of Dionysos at Téos; the temples of Athene Polias at Priene and at Pergamum; and by the majestic Mausoleum at Halicarnassus.

Finally of the Roman period of Greek art, beginning B.C. 146, with the capture of Corinth by Mummius, and ending in the fourth, fifth, and sixth centuries A.D., when classical art was inseparably involved in the overwhelming and conclusive destruction of classical paganism, science, and philosophy, wrought by the invasions of the barbarians, and the persecutions of Constantine the Great, Theodosius the Great, and Justinian I.;—of this protracted period of the progressive Hellenisation of the Roman Empire, thus violently brought to an end through a series of untoward calamities, culminating in the relentless persecution of the old ethnic religion, the architectural remains in Asia Minor are most instructive, and so numerous that it is impossible here to more than merely indicate the best known of them. These are the Roman theatres at Aspendus in Pamphylia, at Patara in Lycia, at Iasus in Caria, and at Æzani in Phrygia, all of the "Composite Order" of architecture; and the Corinthian temple of Venus at Aphrodisias in Caria, the Ionic temple of Jupiter at Æzani, the Corinthian temple of Augustus at Ancyra in Galatea, the "Composite" temples of Jupiter at Patara, and of "all the gods" at Myra, both in Lycia, and the Corinthian temple near the modern Turkish village of *Kisseljik*, wrongly identified by Fellows with the ancient city of Labranda in Caria.

It was by means of the round-headed arch, superimposed upon the lintel,* that the Greeks were enabled to secure that combination of magnitude with impressive stability distinguishing the building style of the imperial period; and, as I have already said, they adopted the expansive framework of the arch from the Etrusco-Italiote architecture of Re-

* The lintel appears above the arch in the later "debased" Roman architecture, in which Byzantine architecture originated.

publican Rome. Yet the universal application of arching and vaulting by them under the Cæsars was probably also in some degree due to the direct reaction at this time of Asiatic, that is, of predominently Assyrian, forms and methods of construction on the Roman world.

The commercial rivalry of the Greeks with the Phœnicians may be dated from the twelfth century B.C., when the Dorians began gradually to dispossess the Phœnicians of their settlements on the islands of the Ægean Sea, so that before the date of the Persian wars in the fifth and sixth centuries B.C., Greece had drawn all the surrounding shores of the Mediterranean Sea within the charmed circle of her Hellenic life. Their victorious resistance to Xerxes and Darius, with the consciousness of superiority it inspired, stimulated their energy in every department of national activity, and in particular served wonderfully to develop their commercial enterprise and influence in the Mediterranean during the hundred years [from Thermopylæ B.C. 480 to Chæronea B.C. 338] of the golden prime of the intellectual power and divine artistic genius of the Hellenic race: and when Carthage, as the military rival of Rome, was levelled to the ground by Scipio Africanus in the same year [B.C. 146] that Corinth was taken by Mummius Achaicus, "the unbruised Greeks" at once took over charge of the commercial business of the Phœnicians in the Western Mediterranean; and after the battle at Actium [B.C. 31],† where the maritime supremacy of the Phœnicians received its last great blow, the Greeks succeeded them in the Eastern Mediterranean also, and in the control of the commerce of the Indian Ocean; and they held the monopoly thus acquired of the whole seaborne trade of the Roman Empire down to the conquests of the Saracens in the seventh and eighth centuries A.D.

† From the fifth century B.C. onwards, Hellenic art began to prevail all over the Mediterranean, and to take its place as an international art. A little later, *i.e.*, during the fourth century B.C., Carthage, influenced by intercourse with the Greeks of Sicily and Italy, and with the Etruscan, and the semi-Hellenic populations of Latium and Campania, must have partly abandoned the poor and unorganised [unassimilated] forms of Phœnician art for that of the richer style she now saw rising around her. Greek rivalry drove the Phœnicians out of the Ægean, and into the Western Mediterranean, and from thence into the Atlantic. The fall of Tyre prevented the Phœnicians from expelling the Greeks from Marseilles, and the efforts of the Carthagenians having also failed to take up role of Greeks in Western Mediterranean, the latter, under the ægis of Rome, became the predominant mercantile power in the Western and the Eastern Mediterranean, and even pushed their adventurous cargoes to the shrouded shores of far off Britain.

The Greeks were now, therefore—about the date of the Christian era—brought, in Phœnicia, Syria, Mesopotamia, and Persia, into familiar and uninterrupted contact with arts that had indeed been already modified by themselves, though the establishment in the fourth century B.C. of the Macedonian dominion of Alexander the Great, and the Seleucidæ and Lagidæ, over all Anterior Asia to North-western India [" India alba "], and in Egypt, but which still, particularly in the building style of these countries, preserved traces not to be found in Greece or even in Italy, of the vague and barbaric grandeur of the Egypto-Mesopotamian temples and palaces of Chaldæa, Assyria, and Babylonia, wherein the architecture and subsidiary decorative arts of the civilised world have everywhere had their origin; and probably it was not less to the intimate intercourse of the Greeks from the time of Alexander the Great and his successors with Anterior Asia, than to the universal influence of Rome under the Cæsars, that we owe the aggrandised features of the almost rankly luxuriant classical art of the Græco-Roman period.

At the same time that Greek art was thus adapting itself to the varied requirements of the Roman Empire, it in turn modified the local art of every nation brought under its influence in the course of the conquests of the Cæsars and the commerce of the Greeks; and to this day in Persia, the Panjab, Sindh, Rajputana, Central and Western India, and other countries of the unchanging East, the domestic architecture is more Roman, that is, of the Pompeian villa, or "country house" type, than in modern Rome itself; a circumstance, undoubtedly, in some part due to the timber construction used in their dwellings by the Aryas wherever they spread themselves, but principally attributable to the direct artistic impress of the Græco-Roman period on these Asiatic regions.

This interaction between the West and the East, produced, between B.C. 226 and A.D. 652, the Sassanian art of Persia.

Again, when classical art, in its later " debased Roman " form, sought a refuge in Constantinople [A.D. 330], from the barbarians who overthrew the Western Empire, it there, in the service of Eastern Christianity, and under the influence of Sassanian, and Indo-Buddhistic, and Coptic art, transformed itself, between the sixth and twelfth centuries A.D., into Byzantine art; of which a strong out-post was planted at Ravenna, in Italy [A.D. 568-752].

Then on the Nestorian Greeks being driven in the fifth and sixth centuries from Constantinople, they fled into Syria, Persia, and Egypt, and from Persia where, as seceders from the Church identified with the Eastern Empire, they were most hospitably received, they spread into Arabia, and Central Asia to the confines of China, and into India, until, in the fourteenth century A.D., their further diffusion was cut short by the conquests and persecutions of the Mongols under Timur. But they had carried with them from the first the nascent principles of Byzantine art, and in the seventh and eighth centuries were everywhere accepted by the Saracen Arabs as their architects and artizans; and limiting themselves, in conformity with the religious scruples of their employers, in part shared by themselves, to the production of floral and geometrical ornamentation, they, on the foundations of Sassanian, Coptic, and Byzantine art, created Saracenic art as the ultimate Eastern expression of Greek art.

Similarly in the West, on Leo III. [Isauricus], A.D. 717, expelling the makers of images from Constantinople, they sought sanctuary in Italy, where, under the patronage of Charlemagne [A.D. 768-814], they gave that direction to the architecture of the Christianized barbarians who had overthrown the Western Empire, which, notwithstanding the continuing vitality of the traditions of classical art in Italy and France, resulted in the development, between the ninth and sixteenth centuries A.D., of the sublime Gothic art of Mediæval Europe.

Such have been the outgrowths from the rudimentary Egypto-Mesopotamian arts of Chaldæa, Assyria and Babylonia, under the fostering influences of the rationalizing, artistic genius of the Greeks: and the debt to it of Sassanian, Indo-Buddhistic, Coptic, Byzantine, Saracenic, and Gothic art, may be learned, not only from the remains of indigenous Egyptian and Mesopotamian architecture, but from those arts of Southern and Posterior Asia, derived directly from Mesopotamia, that have never been modified by the harmonizing touch of the Greeks, or only indirectly and partially, through very imperfect contact with Saracenic art along the secluded commercial coasts, and far remote frontiers of the countries where they have survived the term put to antiquity in Anterior Asia and Europe by the fall of the Western and Eastern Roman Empires, and the rise of Christendom and Islam. Such are the calyptric Hindu arts of Southern or Dravadian India ["India nigra"] and the derived ecclesiastical [Buddhist] arts of Ceylon, Further India, the Indian Archipelago, and of the Chinese and Japanese Indies ["India flava"].

But, if the marvellous adaption to local conditions of the Western forms of Egypto-Mesopotamian art was everywhere the work of the Greeks, and the eastward and westward propagation of them that of the Phœnicians and Arabs, the primitive impulse to the artistic life and activity of the Old World was not given by the "keen-eyed Greeks"* or the "go-a-ducking Phœnicians," but by the redoubtable Hittites, who, advancing their conquering banners

> "—— ——from Syria
> To Lydia, and to Ionia,"

first extended the religous, military, scientific, artistic, and commercial culture of Asia, from Chaldæa, the delta of the Tigris and Euphrates westward to our mighty "sun-set land" of Europe: and this makes their unique importance—by whatever name they may be called—in the history of art, as told by its monuments, the most truthful and trustworthy of the authentic archives of antiquity.

THE NUSHKI TRADE ROUTE BETWEEN INDIA AND PERSIA.

Major F. C. Webb-Ware, C.S.I., Political Agent at Chagai, in Baluchistan, has just issued his report on the statistics of the trade which passed along the Nushki-Seistan trade route during the year 1907-08. Much interest attaches to the efforts to revive the ancient trade which centuries ago used to flow in great volume between India and Persia along this very route. Lord Curzon's encouragement lent a great stimulus to its first opening up, but during the last few years the numbers have fallen away. It is, however, gratifying to see that this decline in business was only temporary, for the aggregate value of the trade in 1907-08 showed an enormous expansion of 82 per cent. as compared with the figures of the previous year, and thus establishes a record since the original opening of the route.

The trade which passes through Nushki is registered at the Quetta-Nushki railway terminus and at a station situated 2½ miles from the bazaar, while the bazaar itself is situated close to a frontier whose chief characteristic is its openness and which can be penetrated at any point. No octroi is levied on goods entering the bazaar, rents are low, living is cheap, and the land on which the bazaar is built belongs to

---

*"The Æthiop gods have Æthiop lips,
Bronze cheeks and woolly hair;
The Grecian gods are like the Greeks,
As keen-eyed, calm, and fair."

Government; so all these circumstances combine to keep prices down, foster commerce, and attract Afghan traders to the bazaar.

Among the exports to Afghanistan there is a noticeable increase under the head of "Animals," this being due to the extraordinary increase in the price of camels, which a few years back cost Rs.60 or Rs.70 a piece, and have now risen to Rs.100, and in some cases Rs.140 or Rs.150. Various causes are assigned for this. Some Afghan traders from Siahband, a mountainous district south-east of Herat, made large purchases of camels and drove them back laden for disposal to their fellow tribesmen. The increase in the Quetta garrison and the opening of the Quetta-Nushki branch railway have contributed to the demand and it is even alleged that camels have been required in connection with the illicit trade in arms and gun-running, of which there has been some sensational instances of late.

Amongst other items showing increased export may be mentioned cotton piece goods, metals and manufactures of metals, and leather manufactured.

Similarly, in regard to Persia, the largest increase was under the head of leather manufactured and unmanufactured, after which came dyeing materials, cotton piece goods, and tea. Generally speaking, the revival of trade with Persia may be attributed to dying out of the plague and the cessation of consequent plague preventive measures, and also to the fact that the insecurity of the up-country routes from Bunder Abbas has led to the Nushki-Seistan route being preferred. The indigo exported is grown chiefly in the vicinity of Multan, and seems to be holding its own against the German synthetic product, while the tea exported is mainly despatched to the Meshed market.

Among the long list of increases in the year's export trade from Baluchistan, piece goods, gunny bags, metals, and manufactures of metals and sugar, refined and unrefined, figure most conspicuously. One transfrontier dealer informed Major Webb-Ware that the profit he realised on a camel load of *ghi* sold in Nushki, and the return camel load of cotton piece goods was equivalent to the profit he would have realised on six camel loads to Kandahar. The imports from Afghanistan are not susceptible of very close analysis, owing to the peculiar system of registration, which only regards those as Afghan goods which pass directly to or from the railway station. Why some system of trustworthy frontier registration at certain fixed points cannot be established, is not explained.

In the imports from Persia, the increases were valued at 93,334 rupees, and the decreases at 30,986, the chief items making up the former, being fruits, vegetables, and nuts, wool, hides and skins, and drugs. As to the first, the expansion was said to be mainly due to an excellent harvest in Mashkel. On the whole, the value of the exports was double the value of the imports, showing that the balance was against Persia, and regret is expressed by Major Webb-Ware that the Persian Government should be so short-sighted as to limit the export of *ghi*, which would have gone far to set matters right in regard to this adverse balance of trade.

In May, 1907, two camel contractors were appointed by the Government of India, one to work from the rail head at Nushki to Dewan Chat, on the Seistan frontier, and the other, under the supervision of the British Consul at Seistan, to convey goods towards India from that point. In the absence of a railway to the Persian frontier, which many authorities strongly urge, the new contract system has worked well. The distance of the railway station from the bazaar and the absence of accommodation for goods are two serious grievances which Government has been asked to remedy. In conclusion, Major Webb-Ware remarks, speaking of the general results of the year's commerce:—"A trade of £150,000 may not in itself be regarded as of any great magnitude, but when it is remembered that the trade has been created solely by our enterprise, in a country where only 12 years ago no trade of any moment existed, and which is, perhaps, one of the most inhospitable in the world, I think it will be conceded that, not only have we great cause for congratulation, but that the results obtained are such as have justified the expenditure, and should encourage us to persevere and not to relax our efforts."

EMIGRANTS IN MEXICO.

In reporting on the trade and commerce of Tampico, Mr. Consul Wilson refers to the advantages offered to British emigrants with some knowledge of farming and possessed of a little capital. During last year several hundred colonists, mostly Americans, settled in the district and are doing well. These colonists have either purchased small tracts of land for farming purposes or have joined one of the numerous colonisation schemes that were started during 1907. These colonisation companies have purchased large tracts of land which they have subdivided into small lots and sell to colonists on deferred payments. The average price is about £1 per acre. Mr. Consul Wilson thinks it doubtful whether these colonists, mostly small farmers accustomed to do all the work on their farms themselves, will be able to perform hard manual work in the hot weather, but other emigrants with sufficient capital to employ Mexicans would get over that difficulty, and it would seem from the Consul's statement that a very good return upon their capital might with fair fortune be reckoned upon.

Take for example orange growing. The land round Tampico suitable for this cultivation is all being rapidly bought up. Virgin soil was sold in 1902 for 16s. an acre within five miles of Tampico. The same class of land is now being sold as high as £10 an acre, to which has to be added the cost of clearing, about £2 10s. The men who started their orange growing

about six years ago are not only making a very good income out of their fruit, but have also made a very profitable business by selling young budded trees to new settlers at £10 per 100. By purchasing and setting out these trees the new settlers can expect a crop within four years. This may be estimated at from 200 to 300 boxes of fruit per acre, worth 3s. a box or more, and the production increases annually until the trees average 10 boxes each, or about 750 boxes of fruit to the acre. After clearing the land and setting out the young trees, a profitable return is secured by planting a crop of potatoes on the same land between the trees. This crop will realise from £20 to £30 per acre, but should not be repeated.

Banana-growing is another profitable industry; and during the past year several large companies have been formed for the cultivation of this fruit. The best lands are along the banks of the Panuno and Tamesi rivers, and can be purchased in large tracts for about £1 an acre uncleared. Plants from Jamaica are being imported in preference to cultivating the native Mexican fruit. Altogether, it would seem that this district offers rather exceptional chances to the emigrant who is not afraid of work, knows something about land, and has a little capital.

THE PLATINUM DEPOSITS OF COLOMBIA.

The mineral resources of Colombia, especially her precious metals, early attracted the attention of the Spanish conquerors, discoverers, and rulers. Indeed, during the Spanish *régime* of three hundred years, the Colombian goldfields were admitted the richest in the world, and down to 1848, when those of California were discovered, they furnished fully one-third of the whole supply of American gold, in spite of the extremely primitive methods employed by the Spaniards. It was while engaged, through their thousands of Indian slaves, in extracting gold and silver from the alluvial beds of the streams and rivers of western and southern Colombia, that the first traces of platinum were discovered. The new metal came to be so highly prized that, in 1804, the Lieutenant-Governor of the Province of Atara, submitted a curious report to the Viceroy, in which the author adduced arguments to prove that platinum is really a kind of white gold. Whether it be true or not that platinum was first discovered as long ago as 1720, it is recorded that 4,202 pounds of it were shipped to the Spanish king in 1788. According to a recent report by the International Bureau of American Republics, platinum first began to attract attention in 1748. It had previously been observed by miners in the Choco and Barbacoas districts of Colombia, but it was thrown aside as useless. In 1720, it is said, the method of separating it from gold by means of quicksilver was known in Popoyan Cauca. The Spanish Government, in 1778, ordered all platinum to be sent to the Royal Treasury, but without offering any remuneration. In years later, eight shillings and sixpence a pound was offered for it in the name of the king, and at the end of 1788, about 3,820 pounds of platinum had been collected in the Choco. The mines then producing most platinum were those of the Opagado, a tributary of the Atrato. The low price paid by the Government led to its being sold to foreigners, who gave as much as £2 10s. per pound for it, and made fortunes by re-selling it in Europe. The Choco platinum is the purest and best sold in foreign markets, as it contains 80 to 85 per cent. of pure metal. In spite of the high price it commands in the world's markets, the working of the rich platinum deposits of Colombia has been so slight that only 661 pounds of it were produced in the Choco in 1905. The district in which native Colombian platinum is found in greatest abundance is in the western department of Cauca, more especially in the central and southern parts of the Choco, Barbacoas and Supia, between the western foothills of the Cordillera of the Andes and the Pacific. The entire territory of this Cauca Department has been renowned, from the earliest days of the Spanish conquest, as the richest of all the mineral bearing sections of Colombia. From 1654 to 1890 the Department, yielded £28,000,000 in gold, of which the Choco region alone produced £23,000,000 or 84 per cent. The most profitable field for the extraction of platinum is on the divide between the heads of the Atralo and San Juan rivers, in the Choco region round Tado, the San Juan, Condoto and Iro. This territory is in the southern and equatorial portion of Colombia. The platinum lies hidden in the auriferous sands and alluvial deposits of streams fed by the melting snows of the Andes, and flowing westward into the Pacific. In these districts is found a zone or layer of gravel, sand, stone, and various clays, and lying within very narrow limits. The lowest part of this layer lies at about 80 or 100 yards above sea level, and the highest at about 800 or 820 yards, and its thickness is about 720 yards. Higher up or lower down, not one grain of platinum has been found. The farther from the sea, the more difficult the extraction. The platinum deposits of Colombia are comparatively accessible for international exportation. Most of the platinum extracted is exported from the Pacific port of Buenaventura, or the Bay of Choco, which is reached in a few days by steamers sailing southward from Panama city. Concerning the position of the best platinum mines of Columbia, an exporter of the metal has stated that the richest mines are on the Rio Condoto, an affluent of the San Juan, the Opagado, and the Tamanal, all branches of the San Juan river. In the province of Atrato there is only one small district from which platinum is taken, namely, Negua. Some new mines have lately been discovered in Nobitu, which promise to be very rich, and a company of French capitalists have recently made very large purchases in the platinum district.

HOME INDUSTRIES.

Railway Amalgamation.—Railway amalgamation is in the air. For some time past it has been rumoured that a working agreement was contemplated between the London and North-Western and the Midland companies, and last week it was officially announced that they "have arrived at an arrangement of a comprehensive character, to endure for a long period of years, which will, it is hoped, be the means of enabling considerable economies in working expenses to be effected, while at the same time the public will obtain the advantage of increased facilities for passenger and merchandise traffic." It will be noted that this is not a mere proposal, a scheme to be discussed, the arrangement has been "arrived at," and it is to remain in force for "a long period of years." To some it will come as a surprise that a far-reaching arrangement of this kind, closely affecting the industrial interests of the country, can be completed without taking the opinion of the proprietors concerned, or obtaining the sanction of Parliament. Be that as it may, it looks as if amalgamation will eventually include all the greater systems. The Chatham and South-Eastern Companies have their working agreement; the Great Northern, the Great Central, and the Great Eastern are appealing to Parliament to sanction a joint working agreement; the Lancashire and Yorkshire have already an agreement with the North-Western, and it has been rumoured that the Great Western is inclined to the combination.

The Public Interest.—The reason put forward, and doubtless the true one, for the arrangement between the London and North-Western and the Midland Companies is the desire to check reckless competition. And that such competition has been common no one acquainted with the facts is likely to deny. It is said that the arrangement between the North-Western and the Midland is expected to save at least £200,000 per annum, and many needless trains might be taken off if reckless competition had not to be reckoned with. But the public have to be considered, and the prospect of working agreements between all the great railway companies of the kingdom will probably provoke opposition. In the official announcement quoted above it is said that "the public will obtain the advantage of increased facilities for passenger and merchandise traffic." But much the same was said at the time of the agreement between the Chatham and South-Eastern Companies, and the promised improvement is not apparent to the traveller by those lines. Moreover, some of the proposers of changes in the railway system of the kingdom assume that they can be made without the sanction of Parliament, but Parliament and the public may have something to say upon that. The railway companies may be able to make out a convincing case for these agreements, but as yet Parliament and the public have not been fully informed of it.

The Middleman.—The middleman has a bad name and it is commonly assumed that in all trades the worker would gain by his elimination. But there are two sides to this as to most other questions, and in some occupations the disappearance of the middleman would in some ways tell against the worker. For example, among Home Workers, as the Select Committee on Home Work which has recently reported point out, there are cases where the person who obtains the work from the warehouse or factory, and distributes it to and collects it from the home worker renders a distinct and valuable service. Indeed one of the most unsatisfactory phases of home work is often the time which is lost and the expense incurred in fetching and returning work. In many cases the cost of tram fares, and the loss of time in the journeys, and in waiting at the warehouse, are together equivalent to a reduction of from 20 to 25 per cent. in the amount which would be earned if there were no such deductions of time or expense. When another person undertakes this the saving to the worker is very appreciable, and where the intervening person does not obtain more than a reasonable remuneration for the service rendered, and the responsibility undertaken, the arrangement is a beneficial one. It is obvious, however, as the Committee point out, that it is one which places the worker very much at the mercy of the middleman, or middlewoman, as the case may be, and opens the door to "sweating." In the opinion of the Committee it is very desirable that, whenever practicable, work that is given out to be done by workers at their homes should be delivered and collected by persons in the direct employment and pay of the employer. An incidental advantage of the arrangement would be that the employer could be kept informed as to the condition of the house in which the work was done.

Electrical Standards.—On the invitation of the British Government an International Congress on Electrical Units is to assemble on October 12, at Burlington-house, and the President of the Board of Trade has just appointed the British delegates. The general object of the conference is understood to be to consider and advise as to the steps which should be taken to bring about agreement in the definition of electrical units which form the basis of legislation in different countries, and in the methods of constructing and employing the electrical standards necessary to give effect to these definitions. It is generally agreed that the ohm should be accepted as one of the primary units, but there is some difference of opinion as to whether the ampere or volt should be the second. It is hoped that the delegates will be able to embody their conclusions in draft articles to be commended to the several Governments represented as a basis for uniform legislation and administration, and in order to guide the delegates certain propositions, embodying the conclusions arrived at by the representatives of the various national stan-

dardising laboratories which met in Germany in 1906, have been prepared.

Paper Yarn.—It has been claimed for paper yarn that it can be made at a price allowing it to replace jute for bagging, and lower than new worsted or jute yarn for use in making carpets, but attempts to buy such yarn have failed to discover any cheaper than 17d. per lb. Samples have now reached the *Manchester Guardian*, however, from a French bleachwork, of a paper thread costing less than half this price. In its origin the thread is said to be German, and its colour in the first condition is a yellow brown, comparable with the colour of tussah silk. This bleaches to a cream colour, which should admit of dyeing in a large variety of shades. In appearance the paper thread suggests more of linen than cotton, and more of twine than of either, the latter resemblance being aided by an odour of size. The thread is sized heavily, and appears to be twisted from a single ribbon of very fibrous paper, similar to Japanese paper. The "feel" is harsh, and the surface is not free from imperfections and projecting fibre. Enough size is used to reduce the inflammability of the material, and size seems to lend the thread a large part of its strength. The breaking strain is enough for many purposes when the thread is dry, but the mass softens to pulp under a thorough wetting. The prices quoted for the thread are roughly $3\frac{1}{2}$d. for $3\frac{1}{2}$'s metric counts (about 2's cotton), and 8d. for 10's metric (equal to 5·90's cotton), to which may be added 1d. for bleaching. The thread may possibly find special employments in the textile and the electrical industries.

British Fire Losses in America.—Last year was an exceptionally good one for the British Fire Insurance Offices doing business in the United States and Canada. The Royal received in premiums no less than 11,775,323 dollars, its percentage of losses and expenses being 93·1. Next in the volume of business done was the Commercial Union whose premium receipts amounted to 7,110,385 dollars, the percentage of losses and expenses being 89·3. The lowest percentage of losses and expenses was that of the Law Union and Crown, 74·3, but its premium income was only 579,198 dollars. The London and Lancashire percentage was practically the same, 74·4, upon a premium income of 4,040,264 dollars. The State received in premiums only 102,066 dollars, and its percentage of losses and expenses was no less than 114·3. This year promises to show less favourable results than last. According to the "Journal of Commerce and Commercial Bulletin" the fire losses in the United States and Canada for the six months of the present year amounted to 126,157,750, dollars as compared with 117,478,400 dollars for the corresponding period of 1907. It may be noted that while the Alliance, the Guardian, and the Yorkshire transact North American business in Canada, only the Royal Exchange and the State do not underwrite business in that country.

GENERAL NOTES.

The Alaska-Yukon-Pacific Exposition.—It may be gathered from Mr. Consul Laidlaw's reference to it in his report just issued (No. 4057, Annual Series), that the preparation for this Exhibition, which opens at Seattle in June, 1909, are being prosecuted vigorously. It is intended primarily:—To exhibit the resources of the Alaska and Yukon territories in the United States and the Dominion of Canada; to make known and foster the importance of the trade of the Pacific and of the countries bordering on it; and to demonstrate the progress of Western America. It will cover no less than 250 acres, and the main buildings which form its nucleus are 12 in number, around which will be grouped the State Territories and Concession buildings. The State of Washington has appropriated £200,000; Oregon and California have made preliminary appropriation of £20,000 each, and other States have also set apart funds for representation, including Pennsylvania, Missouri, Utah, and Nevada. The amount that the Federal Government will spend has not been determined. According to the statements of the management, assurances have been given by New York, Massachusetts, Kentucky, and all the middle Western States, that they will make provision for participation in the Exposition. Mr. Consul Laidlaw thinks British merchants and manufacturers might find this an excellent opportunity for studying conditions of trade.

Lard as a Preservative of Eggs.—Some months ago there appeared in the bulletin issued by the Italian Minister of Agriculture the result of a series of experiments by Dr. Campanini intended to ascertain the best means of preserving eggs. Dr. Campanini, after reviewing the best known means of preserving eggs—by salt water, lime water, silicate of potash, vaseline, and cold storage—described his experiments for which he claimed better results than all others. His theory is that to preserve eggs some system must be adopted that will absolutely prevent the exchange between the air outside and that inside the egg, it being this continual changes that causes putrefaction. Dr. Campanini selected perfectly fresh eggs and covered them with lard so as effectually to stop up all the pores. The shells were thus rendered impermeable, the exchange of air was prevented, and the obstruction of the pores not permitting the evaporation of the water, there was no loss of weight. When properly coated with lard—not too thickly—the eggs are put in baskets or boxes upon a bed of tow or fine odourless shavings, and so arranged that there will be no point of contact between them—otherwise a mould will develop and putrefaction result. By this process Dr. Campanini kept a quantity of eggs for a whole year—through a very hot summer and a very cold winter—and they were perfectly preserved. He says that two pennyworth of lard sufficed to coat 100 eggs, and that any one could easily prepare that number of eggs in one hour's time.

Journal of the Royal Society of Arts

No. 2,909. VOL. LVI.

FRIDAY, AUGUST 21, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

EXAMINATIONS.

The results of the Advanced and Intermediate Examinations (Stages III. and II.) have been published, and copies have been sent to Centres for distribution to all Candidates who sat for examination. It is hoped to publish the results of the Elementary Examinations (Stage I.) next week.

The total number of candidates examined in all three Stages was 22,507. These candidates altogether worked 25,805 papers. The two most popular subjects were, as usual, Book-keeping and Shorthand, in which 8,544 and 6,806 papers were worked respectively.

The Examination Programme for 1909 will be ready in September. The Programme contains the syllabuses of all subjects, also the papers set in 1908, with the Examiners' reports on the same.

TIME TABLE FOR 1909.

	Monday, March 29. (7—10 p.m.)	Tuesday, March 30. (7—10 p.m.)	Wednesday, March 31. (7—10 p.m.)	Thursday, April 1. (7—10 p.m.)	Friday, April 2. (7—10 p.m.)
Advanced Stage.	Book-keeping. Précis-writing. Economics. Danish and Norwegian.	Arithmetic. Commercial Law. German. Italian. Spanish.	French. Commercial History and Geography. Typewriting (7.30 to 10 p.m.).	Accounting and Banking. Shorthand (140 and 120 words per minute) (7.15 to 10 p.m.).	Portuguese. English. Russian. Swedish. Chinese. Japanese. Hindustani.
Intermediate Stage.	Typewriting (7.30 to 10 p.m.). French. Danish and Norwegian. Commercial History and Geography.	Book-keeping. Précis-writing.	English. Economics. Spanish.	Arithmetic. German. Portuguese. Italian. Russian. Chinese. Japanese. Hindustani.	Swedish. Shorthand (100 and 80 words per minute) (7.15 to 10 p.m.).
Elementary Stage.	Handwriting and Correspondence. French.	German. Italian. Typewriting (7.30 to 10 p.m.).	Book-keeping Spanish.	Shorthand (50 words per minute (7.15 to 10 p.m.).	Commercial Geography. Arithmetic.
Music.		Harmony.	Rudiments of Music (7 to 9 p.m.).		

The last day for receiving entries is February 23rd.

The special subject for Commercial History and Geography is:—South and Central America.

ILLUMINATION AND HYGIENE.

By Leon Gaster.

Editor of "The Illuminating Engineer."

At the present time we study the subject of health, and impose sanitary regulations with a thoroughness that would not only have been regarded as unnecessary, but would even have been considered highly ridiculous by our forefathers. We have learned to appreciate the fact that small details affecting the public health, insignificant in themselves, may, in the aggregate, have serious consequences.

To the writer it has long been a matter for regret that the care which is bestowed upon many other important aspects of hygiene has not been extended with a similar thoroughness to the question of adequate light and illumination, and his main object in writing this article has been to bring the matter before the Society of Arts, who have already done so much to rouse an interest in questions of hygiene and education. The present moment is particularly opportune for the study of these conditions. Our methods of producing light have undergone a remarkable development. The old flat-flame gas burner is giving way to the incandescent mantle, the carbon filament electric glow lamp is being slowly but surely replaced by the newer metallic filament lamps, and the flame arc and high pressure incandescent gas are causing a revolution in methods of street lighting. Other still more recent types of illuminants are now making their appearance. We should therefore be acting wisely in taking up the study of illumination at the present stage when the revolution in the methods of lighting may be said to have entered upon a new era, in order that data may be available to settle the more complex problems that are certain to arise in the future. We now turn a great part of night into day, and carry out an amount of work by night that would have been literally impossible only a few decades ago. The amazing growth in the amount of magazines and printed matter now available bears witness to the change that education and improved methods of securing artificial light have brought about. As a whole, we undoubtedly read more than we used to do.

The influence of illumination on health can hardly be doubted. It is only by means of light that we are able to execute our work at all, and if the illumination is defective we naturally experience a greater degree of strain in trying to carry it out. Anyone who has been obliged to live for any length of time in dingy and badly-lighted rooms knows the depressing effects of such surroundings. This point was emphasised by Mr. Patchell in his presidential address to the Association of Engineers in Charge, last November, when he said :—

"Good lighting is conducive to economy in both engine and boiler rooms, as plant in a badly-lighted room never gets properly looked after or cleaned. Why should it? It is no credit to the cleaner if it cannot be seen. Dirt is about the worst disease a plant can suffer from, as it invariably means neglect of small indications and warnings, timely attention to which would prevent the otherwise inevitable breakdown. Not only is the plant better cared for, but men all work better in cheerful surronndings, and lose less time through sickness."

In short, both our work and our health suffer when the illumination is not up to the required standard.

It may be asserted that illumination is now as requisite a commodity as food, air, or good drainage, and deserves to be considered with the same care that is now bestowed upon these. Public attention has already been drawn to the necessity for good ventilation in rooms, and for removing the products of combustion of illuminants to some extent. But there are other questions of equal importance connected with illumination, which are hardly yet sufficiently recognised. Bad lighting, by increasing the difficulty experienced in carrying out even the simplest operation, must indirectly affect the general health. The most direct influence which we must look for is in the deterioration of eyesight of people working under unsatisfactory conditions. In this connection it is singular to reflect that whereas public opinion rightly condemns an employer who coops up his workpeople in an ill-ventilated and insanitary workshop, it does not concern itself in the same way with the possibility that he may be ruining their eyes by only providing a miserable and inadequate illumination. When we remember, too, that children often work in such factories at a comparatively early age, when they are particularly susceptible to strain through working under bad conditions, the importance of insisting on proper illumination, as well as good ventilation and sanitation, &c., becomes the more apparent.

In the case of children in schools, indeed, the necessity for good lighting must be felt to be greater than ever. They are called upon to make special efforts to learn at the most important period in their development, and

the simplest operation undertaken by them, child's play though it may be to an adult, may be a matter of very great effort.

Dr. Kerr, Medical Officer to the London County Council, in his most recent report to the Educational Department, laid stress on this aspect of the question, in the following words :—

"A normal person of middle age will distinguish characters on paper in a poor light with greater readiness than a child, because the characters are more familiar to the adult, and so much more easily recognised. Conversely, a child requires a better light to learn by than does an adult, to whom reading is second nature. From a large number of experiments, the least illumination permissible on the school-desk of a child has been found to be equal to 10 candle-metres."

In 1897 a paper was read before the Society of Arts by Mr. Brudenell Carter, on "The Eyesight of Children." The reader of the paper exhibited some interesting pictures illustrating the unnatural attitudes of children, attempting to write by the aid of light coming from the wrong direction. There is, indeed, ample medical support for the impression that the eyesight of school children requires careful study. Investigations on this point have been carried out with exceptional completeness in different countries in Europe and in the United States, and all have led to the same results. Space forbids these being quoted in any detail in the present article, but reference may be made to the collection of data in the special section of *The Illuminating Engineer* for January of this year.

Thus, Miss Sayer, assistant medical officer to the London County Council, quoted figures at a recent meeting of the International Congress of School Hygiene, to illustrate the steady deterioration in eyesight during school life, and mentioned that in the London schools alone 25,000 children are seriously handicapped by defective eyesight.

Dr. H. Wright Thompson, oculist to the School Board of Glasgow, found that 35 per cent. of the children in the 67 schools visited by him had more or less defective sight.

Professor Scott, in the United States, has quoted even higher figures. A circular issued from the United States Bureau of Information, in 1881, elicited the fact in the highest grades of school life, as many as 60 to 70 per cent. of the children possessed markedly defective sight, and he himself states that he even met with a class in which the percentage rose to 84.

The existence of this deterioration is a matter for grave concern to the medical authorities, and it may be hoped that the systematic medical examination of school children now enforced under the directions of the Board of Education will be of service in suggesting a remedy. The magnitude of such investigations will be readily understood from the fact that there are over a million children in the schools of London alone.

The first necessity seems to be to collect data which will definitely settle what are the conditions responsible for the defects alluded to. It is of course quite possible that our methods of education are partially responsible, but it also seems to be generally agreed that the conditions of illumination in schools often leave much to be desired. Dr. Kerr, for instance, found that of 163 schools visited, the artificial ilumination of about 20 per cent. was classed as only fair, while about 18 per cent. were considered bad. The window-illumination was likewise classed as only fair in the case of about 27 per cent. of the schools visited, while in the case of about 25 per cent. it was condemned. Professor Scott recently reported that the illumination in the schools visited by him in the United States was often very inadequate, and wound up his remarks as follows :—

"Because of the lack of attention that is paid to the light actually present in the schoolroom, and because of the great difficulty in adjusting our windows and shades to the varying intensities of the external sources of light, it is not surprising that we should find in our schoolrooms conditions of lights so bad during many hours and days, that the reading of ordinary printed matter without undue strain on the eyes is impossible."

Attention has been drawn to the conditions of eyesight in schools by the extensive data available. But it is quite possible that an investigation into the illumination of factories and the eyesight of workers therein, carried out with equal thoroughness, would lead to equally disquieting results.

On the other hand, there remains much to be learned exactly as to what is to be aimed at and what avoided in order to secure perfect illumination from the physiological point of view. We realise, for instance, that to place very bright sources of light in the direct range of view of the eyes is physiologically bad, but we still lack a sufficiently authoritative medical determination of the limiting brilliancy of sources of light which can be permitted under these circumstances. In the same way it is desir-

able to study the exact strength of the illumination required for certain purposes. One would also like to know definitely what distinction, if any, exists between the action on the eyes of the light from different varieties of illuminants, such as electric incandescent lamps, gas mantles, acetylene, oil, &c. This last point has been the subject of much profitless recent discussion in the absence of sufficiently authoritative evidence. As a matter of fact it was raised by one of the speakers in the discussion on the paper by Mr. Brudenell Carter already mentioned, and is still unsettled to-day.

All these are questions which require the co-operation of those most closely connected with the different aspects of the subject—engineers, architects, medical men, &c. The value of such co-operation is becoming more and more fully realised. A number of valuable researches have been carried out on the illumination in the schools in Münich, in Germany, and elsewhere, and we hear that the question of providing for adequate illumination in schools in that country, yet to be built, will in future be discussed by a Board of experts, by whom the physiological and engineering sides of the problem will receive due consideration.

Similar valuable work is being done in the United States, in connection with the Illuminating Engineering Society. This society, which is devoted to the subject of lighting and illumination, and which at its commencement only numbered ninety members, has, in less than two years, increased its membership to over 1,000, and numbers among them representatives of many different professions. We may, therefore, hope soon to be in possession of more complete data on the questions in dispute to which reference has just been made.

Meanwhile, we ought to encourage co-operation of a similar nature in this country, and much might be learned by extending the present systems of inspection of schools and factories so as to include the study of illumination. In the face of the evidence available it can hardly be doubted that illumination exercises an influence upon eyesight and upon the general health of the nation. It is not enough to observe defects; we must also study the conditions which are responsible for these defects having arisen. And only by the mutual help of all the different experts interested in the matter can we do this in a really scientific and authoritative way.

Since writing this article the author has observed that independent efforts are being made in the United States to induce the Board of Health to take up the question of devising regulations to guard against the utilisation of artificial illuminants under conditions liable to be injurious to eyesight.

INFLUENCE OF GAS FUMES ON LEATHER.

Mr. M. C. Lamb has lately written a valuable paper on "The Deterioration of Leather under the Influence of Gas Fumes," which has been reprinted from the "Journal of the Society of Dyers and Colourists." After a full account of his experiments and a series of tables of results, Mr. Lamb writes:—

"There is no doubt that chrome-tanned leather, judged from a wearing point of view, is much superior to vegetable-tanned leather, and with reasonable care and treatment there appears to the writer no reason why a book bound in chrome leather should not exist, and the binding be still in good condition, at the end of several centuries. Unfortunately, however, in the ordinary binding there is some little difficulty in the working of this leather by the bookbinder.

"The difficulties presented are—(1) The leather does not adhere well with the ordinary bookbinders' paste; (2) the leather possesses more elasticity and stretch than ordinary tanned leather, and in consequence more care is required by the binder; (3) the leather does not lend itself readily to the production of a permanent bold grain; (4) it embosses with difficulty, particularly if not tannin mordanted; (5) gold blocking is somewhat difficult on chrome leather. These difficulties are really only minor ones and can no doubt be easily surmounted.

"It might be remarked, in passing, that some few American bookbinders have been binding books in chrome-dressed sheep, dressed with a nap or velvet-like flesh-side, the leather being used flesh-side outwards, for some time, the binding taking the form of the old-fashioned box Bible, but without the edges folded over.

"Some four or five years ago, by the courtesy of Mr. F. G. Golding, of the Leather Trades School, the writer had presented to him a number of cuttings taken from skins which had been used for exhibition purposes in connection with boot and shoe classes. The skins from which these cuttings were taken had been hung for a considerable number of years on the walls of a room in the school just mentioned, in which room coal-gas was burned each evening. The whole of the skins, with two exceptions, showed very curious tendering, as will be noticed from the samples exhibited. The pieces of leather include samples of seal and goat morocco, fur seal, East Indian kips, hides, calf and curried leathers, *e.g.*, wax kips and wax calf, alum-dressed leather, and patent or japanned leather.

"The patent or japanned leather had withstood

the action of the heat and gas fumes with a remarkable degree of success due, without doubt, to the protective varnish coating. The alum-dressed leather was comparatively little the worse for the treatment.

"In view of the above discovery it was thought advisable to commence a series of experiments exposing dyed alum leather to the action of gas fumes. This was accordingly done, with the result that it was found that alum-dressed leather was practically equal in gas-resisting properties to chrome-tanned leather.

"Alum-dressed leather does not make an ideal leather, particularly because of the fact that, like chrome leather, it is perhaps a little difficult to manipulate in the making up to produce a pleasing effect when used in binding, but chiefly because extreme care has not been taken by the leather dresser to remove practically the whole of the excess of salt in the dressing. The leather, owing to the presence of salt, is hygroscopic, and when kept in a damp atmosphere absorbs moisture, in extreme cases, to such an extent as to render the leather quite damp. These, however, are technical difficulties, which can be overcome if required.

"The general conclusions to be drawn from these experiments are:—

"(1) That mineral tanned leathers, alum and chrome, under ordinary conditions and if well dressed, appear to be the leathers that will still be in existence and in a state of decent preservation 300 or 400 years hence.

"(2) That tannin mordanting of the above leathers tends to shorten their life.

"(3) That the most suitable vegetable tanned leathers are those tanned with sumach, algarobilla, chestnut extract, myrobalans, and the pyrogallol tannins generally, algarobilla and sumach being particularly useful.

"(4) That the acid dyestuffs must be applied with an organic* acid assistant.

"(5) That it would be well to omit the fixing operation if the dyeing is to be performed with basic dyestuffs.

"(6) The best resistant to deleterious influences of the finishes tried is shellac, and the next best albumen.

THE WORLD'S TIMBER SUPPLY.

The probable coming of a timber famine has been frequently prophesied, and *The Times* of the 18th inst. contains a warning letter on the subject from Mr. Angus Cameron dated from California, upon which letter the same issue of that paper contains a leading article.

Mr. Cameron writes:—"To those of us who have spent the greater part of a lifetime in the international timber trade and have travelled extensively the timber-producing regions of the world, it is a self-evident fact that a time of scarcity is approaching much more rapidly than most people suppose. I would place the time of scarcity at 25 to 30 years. At the present rate of consumption the United States supply will certainly be exhausted in about that time, and Canada, with the United States drawing on it from now on, cannot hold out much longer. All the most accessible timber on the shores of the Baltic has been used up, and the interior supply will be gone in less than 30 years. With conditions like these to be met in so short a time, what are you to do in the Old Country to meet it.

"In the short space of 30 years it would be impossible to meet this famine by planting, and while your home timber is growing it is necessary you should look up some other source of supply. The two most likely regions are the Amazon or the Uganda Protectorate. As the timber regions of Uganda above 4,000 ft. are suitable for white labour, it seems to the writer that this is a much more desirable region to develop than the Amazon, and being within the Empire would be free from the tri-weekly revolutions so common in the South American Republics, consequently giving greater security to the capital necessary to develop the forests.

He continues—"I estimate the timber area of Uganda at 40,000 square miles, that is to say, 25,600,000 acres, which at 1,000 cubic feet per acre would yield 25,600,000,000 cubic feet in all. Why should this enormous forest be allowed to rot on the stump when you need the timber so much at home? It is a self-evident fact in a forest that is perpetuating itself that it decays as fast as it grows, and we know that this decay and growth is about 40 cubic feet per acre per annum, hence there is 1,024,000,000 cubic feet rotting in the forest of Uganda every year. For the benefit of the general reader I may state that this annual decay of timber would, if converted into sleepers, be sufficient for 170,000 miles of single track railway, and all this without injury to the forest."

Mr. Cameron concludes with this advice:—"My advice to you at home is to plant every available inch of ground. Don't say you haven't any. I know of several millions of acres in England, Wales, Ireland, and Scotland that can produce a profitable crop of timber, and which in the interest of coming generations should be planted. Assuredly this timber famine will be upon you in less than 30 years."

On these points *The Times* remarks, "In view of the coming crisis, Mr. Cameron has two suggestions to offer to this country. The first is that it should develop its own potentialities as a grower of timber. But, as that is a remedy which, even if taken in hand to-day, might not not have effect in time, his second

* Since these experiments were first commenced, formic acid has been placed on the market at a price which will allow of its being employed in leather dyeing. This acid is more suitable than either acetic or lactic acid for this purpose. (See "Formic Acid in Leather Dyeing," by M. C. Lamb, *Journal Society of Dyers and Colourists*.

suggestion is that we should develop scientifically the output of other regions, which are neglected at present. More especially he advocates the development of our own territories within the Empire, and, in particulare, those of British East Africa.

"It does not appear that Mr. Cameron speaks with first-hand knowledge of the forest regions of the British East African Protectorate, and we are inclined to think that, important as these may prove in the economic development of the Protectorate, he has greatly over-estimated their possibilities. as a factor in the world's supply. The Mau and Kikuyu escarpments and the slopes of Mount Kenia undoubtedly include some very fine forest. But only a portion of it consists of cedar and other lighter woods, and the heavy African hardwoods would not meet the case of a deficiency in the lighter timbers of Canada or the Baltic which our correspondent foresees. Again, under present conditions of the market it is very doubtful if the timber of the Mau, however cheaply and even recklessly exploited, would stand the cost of 500 miles of haulage over a narrow-gauge line. A serious rise in prices may, no doubt, alter all that; and in the meantime, even if East Africa cannot yet be held out as an Eldorado for the timber merchant, there is everything to be said for the provision of an adequate forestry staff to safeguard and improve its forests with a view to the future."

With respect to the second suggestion, *The Times* expresses the opinion that although there are difficulties, they ought not to be insurmountable if the British Government took the matter up with the necessary energy.

"As regards the desirability of afforestation in these islands there can scarcely be two sides to the question for anyone who has gone into the subject. Even at present prices the forests of Germany and France—to take the most highly-developed industrial countries of Europe—represent an enormous annual and capital value, with which we have nothing to compare, though all over these islands, and more particularly in Scotland and Ireland, there are great tracts at present devoted to far less profitable purposes than forestry. Moreover, forestry is a national industry, which has a considerable social value. The idea, frequently put forward on Liberal and Labour platforms, that afforestation can provide an immediate occupation for the unemployed, is, no doubt, crude enough. Forestry is a highly-skilled industry, requiring trained and experienced workers. It is precisely because it is an industry which can be made to support permanently a large class of skilled and well-paid workers, which suffers little from the fluctuations that attend other crops, and which yields a product that is in constant and increasing demand, that forestry can exercise so beneficial and steadying an influence on the general course of trade and employment. But the afforestation of these islands, if it is to be carried out seriously, can hardly be taken in hand by any other authority than the State.

THE HAT INDUSTRY OF ECUADOR.

The plant known as "planta de Toquilla," grows wild in the low, damp forests of Ecuador, and is extensively cultivated in some localities, yielding the straw from which are made the Toquilla straw hats, known sometimes as Panama hats or Jipijapa hats. The plant is fully developed at eighteen months, and is said to live from forty to fifty years. After a sufficient number of the leaves expand to form shade, harvesting is begun, and consists in gathering monthly the young leaves while yet folded up, though just beginning to open. It is from these that the straw is obtained, the leaf stalk being cut off about five inches below the leaf to facilitate handling. The leaf is opened and two or more of the outer plaits are torn off from each side, as they are too tough to form good straw, and too green to bleach. The remaining portion is torn, plait by plait, these being generally about half-an-inch wide and corresponding to the parallel veins. They are further split into shreds of varying sizes, according to the fineness of the straw required, sometimes with the finger nail, but usually with an instrument, the points of which are needles properly arranged in a piece of wood, the plait being ripped into fibres, which are left attached to the leaf stalk, the waste fragments being torn off and thrown away. The leaf stalks with their numerous fibres attached, are then gathered and submerged in boiling water, afterwards being dried, first in the shade, and subsequently in the sun. In Ecuador it is not usual to add anything to the water in which the straw is boiled, though lemon juice is sometimes added. At times the fibre is used without further preparation other than drying, but a much better straw is obtained by boiling the fibre for a short time. According to the American Consul-General at Guayaquil, the best Toquilla straw is grown in the vicinity of Manglaralto, where enough is produced for the entire demands of the canton, besides supplying considerable quantities to the provinces of Azuay and Cañar, a still larger quantity being exported to Catacaos, Peru, where it is used for manufacturing the well-known hats called "Catacaos." For transportation or export the straw is baled loosely in quantities of 85 to 90 pounds, and generally sells for about 2s. 9d. per pound, but during the month of March last, on account of the increased demand, it brought the unusually high price of 3s. 9d. a pound. Six years ago the same article could not be marketed for more than 6d. or 7d. per pound. The present high price is owing to the large amount of straw now used in making hats for export and on account of the relatively small production, especially during the dry season, the prices ranging from 2s. 11d. to 3s. 4d. a pound. The straw is classified for market into four distinct classes—coarse, medium, medium fine, and fine—the finer and more delicate grades commanding the highest prices. A small quantity of straw is exported to Europe, Germany being the principal consumer. In the province of Guayar are made the hats commonly known in Ecuador as "costeños," meaning a coast

product. As a rule these hats are of an inferior class, but some of them are considered to be very good, many selling for a high price. They are also considered to be of superior workmanship and more serviceable, considering their grades, than those made in other parts of Ecuador. No special preparation is used on the straw or hats to enhance their appearance or finish. The production is comparatively small, amounting to about 500 or 600 dozen a month, nearly all of which are exported, *viâ* Guayaquil. The provinces of Azuay and Cañar, situated in the eastern part of Ecuador, also produce large quantities of Toquilla straw hats. The greater part of those made in the villages of Guaylaquiza and Sigsig are of inferior quality and of greyish colour, on account of the straw being used in its natural state without first preparing it, which is not done in Cuenca and Azoquez, where only well-prepared straw is employed, which produces a better class of hat. Hats made in Cuenca and vicinity are called by exporters "Cuencas" or "blancos," and are peculiar in their make up and style, differing materially from those made in other parts of Ecuador. The monthly production of these provinces is estimated to be from four thousand to five thousand dozen. The principal hat market in the district is Azoquez, where large numbers of buyers and sellers assemble every Saturday. In the province of Imbabura, which lies in the north-eastern part of Ecuador, on the eastern slope of the Andes mountains, they weave the Toquilla straw hats from straw imported from the Cauca Valley, Columbia. The workmanship of these hats is good, but the straw is inferior to that of Ecuador, and the hats are not regarded as being up to the average standard. From one hundred to one hundred and fifty dozen are woven monthly, and are for home demand and not for export. In Manabi Province are woven what are said to be the finest Toquilla straw hats produced in the world. These are known as "Montecristi" or "Manabi" hats, and are especially noted for fineness of fibre and excellent workmanship, the highest grades which are called "Especiales," commanding the enormous price of £20 to £25. A limited number of these high grade "Especiales" are made, as few weavers understand making them, and the demand is small. From five to six months are required to make one of these, as work on this class of hat can only be done during certain hours of the day. The industry is especially well developed in the canton of Jipijapa which produces its full share of the average grades found on the markets, carrying with them their provincial or local name, "Jipijapa" hats, a name well-known in foreign markets. The province of Guayaquil is said to produce the largest quantity of the so-called "partida corriente" and "entrefinos" produced in Ecuador, and the monthly production is estimated at 650 dozens. They are exported from the port of Cazo to the United States, Mexico, Cuba, and to Europe. Some of them also come to Guayaquil and are re-shipped by agents who export them on commission.

THE WORLD'S GOLD SUPPLY.

The following particulars are taken from an article on "The Annual Movement of Gold," by R. L. Barnum, in *The American Exporter*, of New York:

"The annual gold movement has come to be one of the most interesting factors with which the commercial interests of a great nation have to reckon. What is known as the world's floating supply of gold always goes to the market which bids the highest price, and in this way the many millions which are annually exported and imported at such centres as New York, London, Paris and Berlin, have come to have no little significance as indicating the status of each nation's financial and business interests. Taken as a whole, the world produces about 400,000,000 dols. (£80,000,000) in gold every year. Of this amount, the United States and its immediate environs contribute about 100,000,000 dols. (£20,000,000), the heaviest output of any single contributing source coming from the South African mines.

"The total visible stock of gold in the world to-day representing the coinage of the various nations, and the production that is used for the arts, approximate something like 4,500,000,000 dols. (£900,000,000). Of this total, about 400,000,000 dols. (£80,000,000) is held in the shape of coin, which is at the basis of all international exchange operations. Of this vast sum, there is always what the world calls a floating supply; that is a certain surplus stock which can be attracted from one country to another by means of a high money rate or some other form of special bid. Since the remarkable development of trade between the United States and the Latin American nations, we have become heavy exporters of gold to the Argentine Republic and other South American countries of great industrial activity. Most of these transactions are prompted by operations in London exchange, and nearly every fall, there has been an increased tendency to ship gold from New York to London in payment of England's indebtedness to Buenos Ayres. We shall in all probability repeat this movement during the coming fall, and it is only a question of time when there will be a material enlargement of the gold movement between the United States and the Argentine Republic direct.

"Of the 106,000,000 dols. gold (£21,200,000) which was sent to the United States by Europe in response to the high bid of the New York money market last autumn, one-half has already been returned in the form of gold shipments to France and Germany. This has been done without the slightest derangement of money rates at New York, which now rule at the lowest level seen at any time since 1904. We shall undoubtedly ship gold to the Argentine Republic later in the year, when the demand for money at London becomes sufficiently active to make it advantageous for that market to shift upon New York the burden of paying the English indebtedness to South America. In this way, the floating supply of gold will be again diverted to

the market offering the highest bid, just as the present movement of gold between New York and Berlin has been governed wholly by the special inducements offered by German bankers to obtain the floating supply of our metal in competition with the bids of the French market.

"The effect of this international manœuvring for the floating supply of gold was well illustrated by the present outward movement of American gold which set in with the engagement of the first Paris shipment at New York on April 15th last. For a fortnight after that movement started, all of these gold shipments were consigned to Paris direct, and no gold was sent to Berlin until that market made the extraordinary bid through its offer of a remarkably liberal interest allowance on engagements of American gold. By that means the Berlin bankers made an effective bid for the floating American gold, and brought about conditions whereby the Paris market was utterly powerless to secure our metal, unless it made as liberal an offer as the Berlin bankers did.

"Ever since the Boer war, the Paris market has been the chief recipient of the world's floating gold, for the reason that the heavy indebtedness created in France's favour through the English and other foreign borrowings in some way related with the Boer War expenditures, gave the French bankers absolute command of the metal. The high record export year was 1904, when 81.500,000 dols. gold (£16,300,000) left New York for Europe during the annual outflow, which extended from April until the last of September. That operation was wholly explained by the extraordinarily cheap money rates at New York, by the remittance of 50,000,000 dols. in gold (£10,000,000) in payment of the Panama Canal, and by the release of capital tied up in the business ventures before the period of trade depression.

"One of the most hopeful signs of the present situation is the continued enlargement of the world's output of gold. This will add enormously to the floating supply. In this respect we are much more fortunately situated than we were following the panics of 1857, 1873 or 1893. Each of those years marked a period of rapidly expanding credit followed by a gradual diminution in the world's gold production. The gold tide set in motion by the Californian discoveries, were just coming to be a factor when the country was visited by the panic of 1857. The financial unrest of 1873 came at the period when the world's output was indeed at a low point. The severe depression of 1893 came as the direct result of the silver heresy, and while the output of gold was increasing the United States was losing all its advantage through the disappearance of the metal from the channels of circulation, owing to the fear that the standard of value would be debased.

"The outlook to-day is in all respects hopeful. Although there has been a huge expansion of credit, there is not the slightest sign of any cessation in the unprecedented production of gold. And that means a great deal, for the reason that gold is at the basis of all international business operations, and is the one thing needful for any prolonged and real beneficial expansion in our international trade relations. There is reason to believe, too, that the United States as a nation will hereafter become a more heavy contributor to the world's floating supply of gold. While the avenues ot production have been in many cases restricted by the unusual complications connected with the disturbance of last year, the fact remains that a large portion of the gold-producing area of the United States has not been developed as yet to anything like its possible proportions. The enormous gain in the Nevada production alone will soon bring this country into close competition with South Africa as the world's greatest gold producer. Very large interests are now joining in a scheme of development work which is fast transforming a desert wilderness into thriving cities. Yet the Valley of "Dry Bones," as well as the undeveloped region of New Mexico, Montana, Arizona, Oregon and Idaho, is so vast that there are untold areas of possible wealth which have been scarcely tapped at all. The Transvaal mines are now producing about 2,500,000 dols. of gold (£500,000) a week, which, of course, means an enormous aggregate production for the year. Enough development work has already been mapped out in the gold area of the United States to indicate that there will be a new impetus given to the producing movement in the Western section of the United States, and to indicate that the most successful results will be obtained.

"All this will mean enormous enlargement of our trade relations with outlying nations and necessarily a very decided improvement in the general scheme of mining operations.

"Perhaps more than anything else the international flow of gold, and the rather spectacular features attaching to its transportation, bring to the public more fully than anything else the fact that gold, whether in coin or bar, is after all merely a commodity like grain or lumber. It is a commodity first, and a standard of value afterwards. As a commodity it is subject, precisely like others, to the laws of supply and demand."

THE MINING INDUSTRIES OF COLOMBIA.

Mines which were successfully worked a century ago in Columbia, are no longer workable without recourse to scientific processes. There are in Colombia many difficulties in the way of successful mining; the scarcity of labour, the bad climate of many good mineral districts, the difficulty of communication, the scarcity and high price of provisions, and the lack of confidence inspired bv a long period of political disturbance, which, however, is being gradually restored. The district of Colombia most

noted for its gold production is the department of Antioquia. The Cauca comes next, and then follow the departments of Bolivar, Tolima, Santander, Magdalena, Boyaca, Cundinamarka, in the order of importance indicated. Panama is left out as it no longer forms a part of the Colombian entity. The United States Consul at Barranquilla says that Antioquia comprises an agglomeration or cluster of cordilleras, which seem to have been unusually favoured by nature for the formation of gold veins. Unfortunately almost every placer mine there has a proprietor, who is always disposed to sell at a high price, but rarely working his own property. Some parts of Antioquia are yet to be opened to exploitation, for example, the mountains to the east and south-east of Remedios, the rivers Tamar and Ite, the region called "Alcante," the left bank tributaries of the Magdalena (San Bartolome, Nare, and La Miel) where placer and quartz mines have not yet been seriously prospected, and the north-western region (Rio Sucio, Dabeida, Ituango, Sinitabe, &c.), almost deserted at the present time. On the other hand the rich groups have been, and are now, actively developed. The working of the quartz mines or gold veins (in Colombia, gold is often found mixed, not only with quartz, but also with mica schists) requires more work and preliminary expense than that of alluvial mines, or free gold, consequently the number of people engaged in that line is more reduced. Many such mines have remained unproductive for causes of infiltration or caving in. They all possess their history as to richness, frequently very exaggerated. Nevertheless it is a fact that some of them must have been very rich, considering the means and methods used in defending as well as hiding their approach and entry. Ancient tunnels are still found in various places, with iron doors and locked with enormous bolts, as though they had been full of treasure. The miners and aboriginals of Antioquia are, as a rule, very sagacious and alert in the transaction of business, and the foreigner has to be on his guard in dealing with them. The Tigui (Guamoco) region in all probability possesses still unknown riches, and presents a vast field to modern prospectors. The Tigui region has been little worked by the Spaniards, for lack of knowledge as to the bringing of the water on the elevated parts for hydraulic purposes, and can be considered virgin. Since 1890, various companies have been organised for its exploitation. The same as on the Porce, the banks of the Tigui can be easily worked at different points by means of small lateral dams, making it possible to work on alluvions lower than the level of the water. The auriferous mud, as a rule, has a thickness of three feet, sometimes as much as ten feet, and its gold is very fine. Gold is found almost everywhere in Colombia, but is vastly spread, rarely existing in any great quantities in determined places. Going up the Cauca river, and above the point where it receives the Neshi, are found the alluvial mines of Carceres where many companies are now working. In that district a good territory is yet to be exploited, with excellent hydraulic conditional conditions, abundance of water, proper currents and dumping facilities—the three cardina. requisites for the proper working of an alluvial mine. All the rivers emptying into the left bank of the Magdalena are auriferous. Lying between the Cauca and the high Magdalena many unworked gold veins are to be found, as also alluvions at the foot of the hills, west of Purificacion, Matagaima and Neiba[1] In the Department of Cauca, from the Patia River to the San Juan, all the rivers emptying into the Pacific Ocean are auriferous, but excepting a few, have been little examined. Various ancient mines are to be found in the neighbourhood of Popayan and in the districts known as Catogo, Anserma and the Vega de Supia. The Choco region in the north-west division of the Cauca Department, is a vast territory whose hydrographical situation bears a great deal of analogy to the western coast of the United States, and it would seem to belong to the same geological period of formation, and it is to be supposed that the same factors which formed the great mines on the western slope of the Rocky Mountains, acted identically on the western slope of the Cordillera of the Andes. The Atrato River and the valley of the San Juan River cover an immense region of alluvion of which a great part is rich and workable. The entire population is of African descent, except for a few thousand civilised Indians. The mining regions of Medio form an immense deposit of gold. On the divide between the heads of the Atrato and the San Juan, is found the "Tado" group which produces platinum, until lately exploited by a few isolated Indians only, but recently made a Government monopoly. In 1905 the Choco produced over six hundred pounds of platinum, mostly from Tado, the San Juan, Condoto, and Iro. The Boliviar and Atlantico Departments, whose respective capitals and principal cities are Cartagena and Barranquilla, contain many important deposits of petroleum. A company has been recently organised, and is now boring prospective wells near the Atlantic Ocean. A concession has been granted to a Colombian for the working of the petroleum and coal lying between the Sinu and the Gulf of Darien, but nothing has been done as yet by the concessionaire by way of actual prospecting. Copper deposits are also found in the Department of Bolivar, near the lagoon of Simiti, which has water communication with the Magdalena. A Barranquilla company has lately started preliminary works on a copper mine at Sabaneta. The Department of Cundinamarca, capital Bogota, although poor in precious metals, is rich in coal deposits. Being far from water transportation, its coal is only used for local industries and a few miles of still unfinished railways. The Department of Boyaca is more or less in the same condition. Coal is found, and in this department that the several mines are situated—about one and a half hours' ride from the small town of Muzo. The

Muzo district, though hot, is healthy; water and timber are abundant, and the land is fertile. Labour also seems to be easily obtainable. The emerald deposits vary in height from 3,000 to 4,000 feet above the sea level. Their area extends over many leagues, the Government property alone being estimated at 100,000 acres. It has been estimated that if certain recommendations are carried out and the mines are properly worked, there shonld be an annual profit of £200,000. In the Department of Santander quartz mines exist, which were worked by the Spaniards, and were, according to reports, very rich. Petroleum is found north of Cucuta. The Magdalena Department, capital Santa Marta, is practically unexploited with regard to its minerals. The presence of gold, however, is noted in some of its rivers, which coming down from the mountains throw their waters into the Caribbean. South of the Goajira Peninsula, near Rio Hacha, large coal deposits have been found that could easily be made exploitable by building a short railway to the port. The programme of the new Colombian Administration is to construct more railways and the work in that direction is now progressing.

HOME WORK.

How to ensure what may be called the residuum of workers a living wage is among the most difficult problems with which the statesman has to deal. Recently the House of Commons appointed a Select Committee to consider and report upon the conditions of labour in trades in which home work is prevalent, and the report of the committee was presented before Parliament adjourned. The committee have found that if the term "sweating" is understood to mean that the employer makes an altogether inadequate payment for work upon which he obtains a large and quite disproportionate profit it is not common, but if "sweating" is understood to mean that work is paid for at a rate which, in the conditions under which many of the workers do it, yields to them an income quite insufficient to enable an adult person to obtain anything like proper food, clothing, and house accommodation, sweating prevails extensively. There are three main groups of home workers—(1) The employer who works in his own home and employs other persons from the outside; (2) the employer who works in his own home and employs only members of his own family; and (3) persons who do not employ any other person, but who undertake work for others and do it in their own homes. The first two classes must be registered, the third is outside the protection of the Factory and Workshop Act; it is the third with which the committee more particularly concerned itself, and which, beyond doubt, is the least able to look after itself. Those who form this third group may be described as follows:—(1) Single women, widows, wives deserted by or separated from their husbands, and wives whose husbands are ill or unable to work; (2) wives who obtain work when their husbands are out of employment; (3) wives and daughters of men in regular employment who wish to increase the family income. The committee found a great diversity in the rate of actual earnings per week amongst persons who were receiving the same rate of pay per article or per process. Some are much quicker than others. There is much difference in the extent to which workers have the most efficient tools and appliances. Sewing machines vary considerably in speed and time-saving fittings. Workers vary in the speed at which they can continuously drive them. The class of work also varies. Low-class work at low rates often gives larger earnings than better work at higher rates. With very many of the home workers the earnings are pitiably small, and the explanation is not far to seek. Much of the work is sewing, and requires little or no previous training, consequently it is work to which almost any woman may turn when the need arises. Then the work can be done at home, and so is desired by a large number of women who would find it impossible or difficult to undertake work in factories. Again, the payment for home work is necessarily at piece rates, and those who find it difficult to secure and retain employment elsewhere find it comparatively easy to obtain this kind of work, and drift into it and settle down to it as a method of earning a livelihood.

The home worker is handicapped by her conditions and appliances. Most of the home workers are engaged in the production of articles in competition with machinery, and the cost of making these articles by machinery fixes the rate which can be paid to them. It is largely a repetition of the old difficulty of the hand-loom weaver with his loom at home competing with the power loom in the factory. There is, too, a large section of home workers who have to meet competition of a different kind. They are makers of baby linen and lady's blouses and underclothing, articles which most of those who require them can make for themselves. They are willing to pay others to make them if the price is low, otherwise they will buy the materials and make the articles at home. Women home workers—and home workers, though not exclusively, are almost entirely women—are very poor and helpless, and work separately. They are unorganised and do not work together to promote common interests and secure better and uniform rates of payment. As the Report of the Labour Commission in 1894 put it, "the natural difficulty in most highly skilled occupations of organising persons who work at home or are dispersed through numerous small workshops, even if it can be overcome in the case of men, would seem almost insuperable in that of women." The protection which is given by the Truck Act, 1896, to workers in regard to deductions for supply of materials, bad work, &c., only applies very partially to home workers, and the Committee are of opinion that the past attempts of

the Government Departments and various local authorities to secure a fair rate of wage to home workers have failed to produce any real amelioration of the condition of home workers, and that "legislation of a far-reaching character is required."

How is this to be effected? Two proposals seem to have attracted the Committee, the one that it should be rendered illegal to give work to any out-worker in certain specified trades, unless the worker had previously obtained a license from a Government factory inspector, which would require renewal every six months, the condition for obtaining it being that the premises in which the work was to be done were clean and wholesome, adequately lighted and ventilated, and not overcrowded. But the Committee do not see their way to recommend registration. An increased number of inspectors would be required and registration would place great difficulties in the way of an exceptionally poor and helpless section of the community earning a livelihood. The other proposal, and the one which the Committee recommend, is that in certain specified trades, a Wages Board, consisting of representatives of employers and workmen, with a neutral chairman, should be established, with power to fix the minimum rate of wages to be paid to workers in these trades, the payment of a lower rate than that fixed to be a punishable offence. The Committee would at the outset limit the scope of the Board to home workers engaged in the tailoring, shirtmaking, underclothing, and baby linen trades, and in the finishing processes of machine-made lace. The Committee refer to Mr. Avis's report on the working of Wages Boards and of Conciliation and Arbitration Acts in New Zealand and Australia, in support of their recommendations, but Mr. Avis's report (Cd. 4167) concludes with the following words:—"For various reasons, therefore, the evidence does not appear to justify the conclusion that it would be advantageous to make the recommendations of any special Boards that may be constituted in this country legally binding, or that if this power were granted it could, with regard to wages, be effectively exercised." The Committee's proposal represents a very considerable new departure in industrial legislation, and adequate data are wanting to warrant a confident opinion as to whether Parliament would be well advised in accepting it.

MEXICAN DRAWN WORK.

The city of Aguas Calientes, capital of the State of the same name, may be considered the particular home of the drawn work industry in Mexico, although it is carried on in many other parts of the country. At Aguas Calientes it is the sole occupation of a large proportion of the female population. The commercial value of the work was practically unrealised until about twenty-five years ago. At Aguas Calientes it is the sole occupation of women of the poorer classes, who possessed patterns which had been for a long time successively handed down in the same family. According to the United States' Special Agent in Mexico, these patterns or designs were jealously guarded. The work was crude, and in many of the old designs the lack of a proper idea of construction is plainly evident. Commencing in one corner of the cloth square the worker proceeded to work round the square, irrespective of the pattern, and when the ends met, a discrepancy in design naturally resulted. The work was fringed, but not buttonholed, and the edges were consequently uneven. These imperfections may doubtless have been the outcome of copying designs again and again by those who had never been systematically taught until the original perfect form was lost. In the modern pieces, the difference is at once noted. The improvement in the modern drawn work, over the old, is largely due, first of all, to the energy and untiring efforts of a certain philanthropic American woman who became interested in this Mexican work, and the women workers of Aguas Calientes. First, these women were taught to do buttonhole stitching, later they were shown how to make a hem, and to hemstitch. It was then demonstrated to the workers that it was possible to inaugurate a system in the work, as well as in the design, and that by counting the threads—since the process of the work is first to draw the threads, then stretch the cloth in a wooden frame, and afterwards weave in the design with a short fine needle—they would be able to make the design fill the square with uniformity. Systematic and intelligent teaching followed, until from the straight work on pillow cases and napkins, the women become able to accomplish the elaborate designs which are now for sale not only in Mexico but are exported in considerable quantities. The work was also taught in the schools for girls. More or less difficulty was experienced in an endeavour to convince the workers of the practicability and personal advantage of working collectively and outside their own homes. For some years the women refused to do this; latterly, however, they have consented to go to localities where the rooms are of a size to enable them to work on the longer pieces, such as bedsteads and tablecloths which cannot be made in their small dwelling-rooms. The greater part of the work supplied to local dealers is usually performed by contract, and it is said that the workers average a daily wage of from 3½d. to 6d. Each person works on one design only. The linen used is practically all of Irish manufacture. So characteristic is this particular handiwork of the country that articles with drawn work designs are universally found in Mexican homes, from the square of coarse cotton thus embellished, covering the dinner basket of the poor, to the finest of linen tablecloths, exquisitely wrought, on the tables of the wealthy. No accurate statistics, either of the number of persons employed in this

industry or of the value of the output are obtainable, but as regards the latter it is estimated that in the State of Aguas Calientes alone, the annual value amounts to £156,000. This estimate is based upon the amount and valuation of the linen used in the manufacture of the articles. It is claimed that the Mexican workers are unexcelled in the beauty of their product either for intricate designs or fine workmanship.

THE SOCIETY OF DYERS' PRIZES.

The Council of the Society of Dyers and Colourists offer prizes for the solution of the technical problems specified below.

The Silver or Bronze Medal of the Society is offered for a full investigation of the mordanting properties of various tannin materials, more especially—(*a*) As to the relative affinity for cotton of the tannins of galls, myrabolans, sumach, dividivi, &c. (*b*) As to the relative fastness of the colour lakes produced with these tannins and basic colours, in conjunction with antimony, tin, and iron. (*c*) As to the best method of determining by volumetric analysis, or other means, their relative mordanting power.

The Silver or Bronze Medal of the Society for the best critical essay (not exceeding 10,000 words) on the treatment of effluents from dyehouses and textile factories.

Prize of £10 for a determination of the average degree of diminution in strength of cotton yarns brought about by different bleaching processes.

Prize of £20 for a full investigation of the average degree of tendering brought about in cotton yarn by —(*a*) Cross dyeing with acid colours; and (*b*) Dyeing Aniline Black; with the object of fixing standards for the trade.

Prize of £20 for a practical method of causing kemps, when present in yarn or piece goods, to take dyestuffs equally with the accompanying wool.

Prize of £10 for a practical method of dyeing full shades of basic colours on cotton fast to rubbing.

Prize of £20 for a satisfactory standardisation of the strength and elasticity of cotton yarns of various qualities and twists in the grey condition.

The Silver or Bronze Medal of the Society for a full investigation of the influence of the various substances present in natural Indigo in respect to their influence upon the dyeing of wool by the fermentation vat, and the depth, bloom, and fastness of the shade obtained.

Prize of £20 for a method of permanently treating cotton, dyed with sulphide black, either during or after dyeing, to entirely prevent the subsequent development of acid and consequent tendering, either upon storage, hot pressing, or stoving.

Further particulars can be obtained from Mr. Ernest T. Holdsworth, Hon. Sec., Pearl Assurance-buildings, Market-street, Bradford.

HOME INDUSTRIES

Trade Depression.—In face of the heavy decline in exports and imports during recent months, and especially as shown by the last returns, it is not surprising that sombre predictions are being made as to the probable course of trade. Fat years are invariably followed by lean years. The last period of inflation was prolonged; the inevitable depression was delayed by various causes, chiefly by wars. When it came it was quickened by a deficient world-harvest, the crisis in the United States, and the dearness and scarcity of money due to that crisis. It is not to be expected that it will pass away immediately, or in a few months, but there is nothing at present to exclude the hope that recovery will not be very long delayed. It is assumed by many that the present depression in the United Kingdom is much more severe than with our leading commercial rivals, but this opinion is hardly borne out by the facts. Take the United States. For the past quarter, the value of the goods imported into the United States was only £53,000,000 against £74,000,000 in the corresponding quarter of last year, a decline of over 28 per cent. In the same quarter, the value of the exports from the United States was £73,000,000 against £86,000,000 last year, a shrinkage of 15 per cent. There is no better index of the relative activity of the trade of a country like the United States or the United Kingdom than railway earnings. The earnings of American railways in recent weeks show a decline of about 21 per cent. The railway receipts of the United Kingdom for the half-year ended June 30th were only about 1·4 per cent. less than they were for the same period of last year, and for the four weeks of July the decline, though greater, is only 2·1 per cent. If we limit the comparison of trade returns to the present and last year the present decline is heavy, but if the comparison is with 1905, itself a record year, it will be found that there is no retrogression. If there is much in the trade outlook to warrant uneasiness there is much, too, to warrant the hope that the period of depression will not be very prolonged. The world's harvest promises this year to be a good one, and during the last twelve months the United Kingdom has supplied £51,000,000 of capital to Indian, Colonial and foreign railways, and including the capital raised for construction by Government loans the total amounts to nearly £70,000,000. In the previous twelve months the United Kingdom supplied other countries with some £40,000,000 of capital for railway construction, directly and indirectly, and many more millions will be supplied during the next two or three years. This investment of capital cannot fail to stimulate our trade with other countries. The cotton crop promises to be one of the most abundant ever known, which means much for Lancashire, and our home harvest promises to be near an average. That the coming winter will see a considerable increase in the number of unemployed as compared with last year is, it is to be feared, certain, and that the sharp de-

pression in certain trades, more especially shipbuilding, will continue is equally probable, but as compared with other countries our trade outlook is not bad, and though there is not likely to be any visible improvement this year it is not unreasonable to anticipate a change for the better in the course of next year.

Does Overtime in Engineering Shops Pay?—Most employers profess to disbelieve in the policy of overtime, and particularly of systematic overtime, and the trade unions are officially against all overtime, save to effect urgent repairs; but many of the men themselves like it since it adds to their income. Obviously overtime is imperative upon occasion in the case of many breakdown jobs. A mill engine is stopped through an accident, and the whole of the operatives are idle until the repair has been effected. Here overtime must be worked to get the mill running again as quickly as may be. Then unequal distribution of work in the shops may necessitate overtime. Or one or two jobs may be delaying the completion of an order, and overtime may be necessary on these jobs. Or fluctuations in trade may necessitate overtime. But does it pay? At present, overtime in the engineering trade costs 25 per cent. more than ordinary time, and occasionally very long hours have to be worked, and then double time has to be paid, after the first two hours of overtime usually. Discussing the subject, a well-informed correspondent of the *Manchester Guardian* points out that extra long hours reduce efficiency, particularly in manual work or brain work. Machine tending is the least influenced in this way, but there are great differences in machine work. Thus a heavy planing, or turning, or boring job may require comparatively little attention, and during most of the time the output from the machine may be independent of the alertness of the operator. In such cases the efficiency of overtime work is practically the same as that during ordinary hours. Where the operator has to give close personal attention to his machine, as in much lathe, planer, and drill work, there is always a falling off in the rate of output with increased hours. Indeed, one of the arguments in favour of the 48 hour week in place of the 53 hour week is that the gain in efficiency, due to the reduction of hours, practically balances the apparent loss due to a reduction in working time. Add the additional 25 per cent. which the employer has to pay for overtime, and it would seem that however natural it may be for the healthy and industrious worker to welcome overtime, it cannot pay the employer to resort to it save upon very exceptional and pressing occasion.

Shipbuilding.—The output from the shipping yards on the Clyde for the June half-year was smaller than in any similar period for the last twenty years, with the one exception of 1893. In that year it was only 118,699 tons; in the six months to June last it was 140,149 tons, as compared with 302,847 tons in the first six months of 1907, and 336,258 tons in the similar period of 1906. And it must be remembered that on the Clyde shipbuilding is less affected by the influences that affect the demand for tramps than are the north-east coast rivers. Nor has there been any serious interruptions from strikes. On the Wear, which was not directly associated with the strikes on the Tyne and the Tees, only two vessels of 5,730 tons were launched in June, and in the six months ended June only 15 vessels of 32,360 tons, as compared with 48 vessels and 154,000 tons in the corresponding half of last year. The comparison on the Tyne is as unfavourable, and on the Humber shipbuilding is stagnant with many incomplete vessels left in builder's hands. Second-hand steamers can now be purchased at 20 to 25 per cent. less than last year, and it is said that new steamers have been sold as low as £5 per ton of dead weight carrying capacity, probably the lowest price on record. These were unfinished vessels built for owners unable or unwilling to take delivery, but builders of tramp steamers are said to be willing to take contracts at something under £5 10s. Nor is there any relief to stagnant shipbuilding by increase in the amount of repair work which is understood to pay builders better than constructional work, the amount of repair work on most of the rivers being under normal. Apparently owners have preferred to lay up their vessels rather than run them at loss. There is little likelihood of early improvement in this distressing state of things. The excess of tonnage afloat will be reduced by the normal wastage to more reasonable proportions if only shipowners are not too eager to anticipate a revival in the sea-going trade, but with the trade outlook all over the world what it is the present prospect of the shipbuilding yards is of the dreariest.

The Hop Crop.—The acreage under hops this year is smaller by between five and six thousand acres than it was last year when the acreage was smaller than it had been within living memory. So far as the crop itself is concerned, the prospect is said to be excellent. Given a continuance of favourable weather, and the yield per acre may well be a record one, but of course the outlook may be entirely changed should there be cold, wet weather between now and picking. The special report of *The Times* says that, taking Kent as a standard, the hop prospects of recent years were and are as follows:—In 1906, 55; in 1907, 79; and, in 1908, 98 per cent. Such a rapid improvement in prospects during three consecutive years ought to alleviate the depression under which hop growers have been suffering, "as an improvement (if borne out at picking time) of about 20 per cent. is a better solace than any Government could confer by legislation." But to the hop farmer the highest crop has never necessarily meant the biggest profit. Whilst an abnormally large crop means heavy increase in the cost of picking the fall in prices may be so severe as to leave little or no margin of profit per acre. This is likely to be the case this year since most of the foreign hop fields are said, like our own, to be promising well.

GENERAL NOTES.

MOXA.—During 1907 the export of moxa from Wuchow amounted to 417 cwts., but for that year no return of the amount exported through the native Customs was furnished. Moxa is prepared from the young leaves of the *Artemisia Chinensis*, and is exported principally to Japan, where it is enclosed in small wooden egg-shaped holders, the top part of which is made to unscrew in the style of menthol cases with us. It is then largely re-exported to China, its medicinal qualities being held in high repute by the Chinese, who apply it externally in cases of cold and fever. Its cultivation in the T'êngshien and Hsunchou districts, says Mr. Consul King (No. 4065, Annual Series), where it has been recently introduced, seems to have been successful.

THE BEIRUT-RAYAK-ALEPPO RAILWAY.—This railway seems to be slow in manifesting its commercial importance. Reporting on the trade of the vilayets of Aleppo and Adama (No. 4061, Annual Series), Mr. Consul Longworth says that most of the merchants who experimentally used the line have reverted their trade to the caravan route of Alexandretta. The high rates maintained by the company, the Beirut quay dues, and the damage sustained at Rayak, leave, it is said, no margin for profits. The extension of the line from Aleppo to Tek-Habesh remains in suspense. Needful as a line northward may be to the province, its construction, says Mr. Longworth, is deferred to an uncertain and perhaps distant future. In the meantime, there is some talk of building a branch line from Homs to Tripoli, which, if realised, would, in all probability, divert traffic to that small port from Beirut and Alexandretta.

FISHERMEN'S MUTUAL RELIEF SOCIETIES.—There seems to be nothing in this country quite like the provident or mutual relief societies among the Calais fishermen, which are described by Mr. Consul Payton in his report (No. 4068, Annual Series) upon the trade of the district of Calais. The first of these societies is concerned with crews of coast fishing boats, called "Association de Prévoyance," being practically a mutual insurance society for boats and gear, loss or damage to which is indemnified at a proportionate rate at the end of each year. The members at the beginning of 1907 numbered 196; their material insured being estimated at £8,248. The second is the "Caisse de Sœurs," or relief fund for the benefit of families of fishermen lost at sea, and men injured on fishing or on pilot boats. Relief is granted under several categories, first of which for cases of death, gives £24 to the widow and £4 for each child under 13 or helpless, with proportionate rates for other cases. Weekly relief of 8s. up to the limit of 20 weeks is granted to fishermen incapacitated from work, and they also receive gratuitous medical attendance and medicine. The funds are provided in the cod fishery by annual payment by owners of 1 franc for each man of the crew, and a deduction of 1 per cent. on wages; in the home fisheries, by deduction of 1 per cent. on proceeds of sale of fish; for pilot boats, a payment of 6s. 6d. per month made by the master. Sundry donations and legacies also swell the total. These contributions are said to be regularly and easily collected. The receipts of this society in 1907 were reported to amount to £216, and sums paid out to £206.

EMIGRATION FROM GREAT BRITAIN TO CANADA.—The immigration figures given in the last monthly report of the Department of Trade and Commerce of Canada are suggestive. They show that the preponderance of British immigration is maintained. The latest figures given enable a comparison to be made between the immigration for the year ended April 30th, 1908, with preceding years. The most noticeable fact in these returns is the rapid growth of immigration during the last few years. In 1898, the total immigration was only 24,432; in the year ended April last it was 163,123. In 1898, the total immigration of British origin was 16,889, and of foreigners 7,464; in April, 1908, British immigration had increased to 131,581, and of foreigners to 31,542, in other words, whilst the foreign immigration had a little more than quadrupled, the British had increased more than eight times. Of the total British immigration in the year ended April last 96,788 was English, whilst the Scotch, which in 1898 was only 1,350, numbered 26,704. Until recently hardly any Irish emigrants went to Canada, but last year they numbered 6,924.

ZANZIBAR.—Commenting on the trade of Zanzibar, Mr. Consul Sinclair directs attention once more (No. 4058, Annual Series) to the rebates and preference granted to German and French shippers by the Deutsche Ost Afrika and the Messageries Maritimes Companies, which are both heavily subsidised by their respective Governments. British merchants are thereby placed at great disadvantage as compared with their foreign rivals. Probably more than half of the cargo and passenger traffic—the accommodation for the latter, says the Consul, hardly equals the demand—is British, and it is to be hoped that in view of the great and growing importance of the British possessions on the East Coast of Africa, it may before long be found possible to establish a British line both outward and homewards. The Consul considers it unfortunate that the British East Africa Line and the British Indian Steam Navigation Company, which also runs a monthly outward service from London, instead of combining against foreign competition, entered into a rate war, which resulted in a drop in freights from £1 15s. to 7s.; and that with the subsequent withdrawal of the British homeward service, and of the British Indian service to and from Bombay, British merchants are again left to the mercies of foreign lines.

Journal of the Royal Society of Arts

No. 2,910. VOL. LVI.

FRIDAY, AUGUST 28, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

SWINEY PRIZE.

The Council have to give notice that the next award of the Swiney prize will be in January, 1909, the sixty-fifth anniversary of the testator's death. Dr. Swiney died in 1844, and in his will he left the sum of £5,000 Consols to the Society of Arts, for the purpose of presenting a prize, every fifth anniversary of the testator's death, to the author of the best published work on Jurisprudence. The prize is a cup, value £100, and money to the same amount; the award is made jointly by the Royal Society of Arts and the Royal College of Physicians. The cup now given is made after a design specially prepared in 1849 for the first award, by D. Maclise, R.A.

In accordance with the arrangement with the Royal College of Physicians, the award next year will be for Medical Jurisprudence.

Any person desiring to submit a work in competition, or to recommend any work for the consideration of the judges, should do so by letter, addressed to the Secretary of the Society.

The following is the list of the recipients :—

1849. J. A. Paris, M.D, and J. Fonblanque, for their work, "Medical Jurisprudence."
1854. Leone Levi, for his work, "The Commercial Law of the World."
1859. Dr. Alfred Swayne Taylor, F.R.S., for his work, "Medical Jurisprudence."
1864. Henry Sumner Maine (afterwards K.C.B.), D.C.L., Member of the Legislative Council of India, for his work, "Ancient Law."
1869. William Augustus Guy, M.D., for his "Principles of Forensic Medicine."
1874. The Right Hon. Sir Robert Joseph Phillimore, D.C.L., for his "Commentaries on International Law."
1879. Dr. Norman Chevers, for his "Manual of Medical Jurisprudence of India."
1884. Sheldon Amos, M.A., for his work, "A Systematic View of the Science of Jurisprudence."
1889. Dr. Charles Meymott Tidy, F.C.S., for his work, "Legal Medicine."
1894. Thomas Erskine Holland, D.C.L., for his work, "The Elements of Jurisprudence."
1899. Dr. J. Dixon Mann, F.R.C P., for his work, "Forensic Medicine and Toxicology."
1904. Sir Frederick Pollock, Bart., and Professor F. W. Maitland, for their book on "The History of English Law before Edward the First."

TAINT IN HAMS AND BACON.

By Loudon M. Douglas,
Lecturer on the Meat Industry, Edinburgh.

Although such vast quantities of ham and bacon are produced, there has been very little attempt to understand the actual processes which occur in the transforming of the fresh pork into the finished article. The process of curing has varied very little for centuries, and the only difference between the present day system and that which was in vogue a century ago, consists in using less salt than formerly; so that whereas cured meats at one time were heavily salted, they are now lightly salted—in order to produce what is called "mild cured bacon" or "mild cured hams."

It is a mistake, however, to suppose that the mere dissolving of the salt, or any other ingredient which may be placed on the fresh meat, has the effect of "curing" the meat. It has no such effect, but really only prevents the development of the germs of putrefaction.

In this connection it is interesting to note that the germ which produces taint in meat has been isolated. We are indebted to Dr. Klein for accomplishing this result, and his notes on the subject are of the most interesting character.

Dr. Klein states that his examination of the muscular tissues of tainted meats,

showed that they were more or less discoloured. In very slightly tainted portions, the colour changed to a pale or dirty grey tint, while in strongly tainted portions, the colour approached dirty green, and the microscopic examination of the muscles disclosed the fact that *tyrosine* was present. The origin of this crystalline nitrogenous product is somewhat obscure. It was discovered by Liebig in animal tissues, and attributed by him to decomposition of the albuminous substances present.

The notable feature is that in the presence of taint a very powerful and objectionable odour emanates from the various joints.

In the various specimens of tainted meats examined, it was found that a species of microbe predominated everywhere, and more especially in the parts which were highly tainted. These microbes exist in the form of cylindrical rods, only visible to the eye by means of a powerful microscope. But the same appearances occur throughout the connective and fatty tissues of the meat, and, if the tissues are undisturbed, the rods will present the appearance of being continuous, but very easily get broken up into short segments.

This particular microbe, which Dr. Klein has named "Bacillus Fœdans," is not possessed of the power of moving, such as is characteristic of many other germs, but must rely for its progress on gradual multiplication. This feature, therefore, explains why it aggregates in some parts more than in others. The microbe is incapable of growing freely in the air or if it is exposed to oxygen (Anærobic), and it is also incapable of forming spores or seeds and, curious to say, the ordinary methods of culture of micro-organisms seem to be quite useless in this particular case, inasmuch as the usual media do not seem to support its growth.

The principal characteristic, however, of the experiments which have been made is that while the germ grows in substance like milk, a most disagreeable odour is emitted. Subcutaneous injection in guinea-pigs did not produce any local or general disease, thus showing that the germ has no injurious effects.

The facts which have been established in these investigations are very helpful in the process of curing. There can be no doubt that the germ is produced in meat from decomposition, which may be set up in several ways. If the meat is insufficiently chilled before the curing agents are used, or if the animals have been slaughtered immediately after a journey in which they have been knocked about, then putrefaction will almost certainly supervene. These germs, however, may be taken up in the cellar itself, and, as they are so very small that some hundreds of thousands of them can rest on the point of a needle, then it will be understood that once they have obtained a location in a cellar, they are apt to remain there.

I am of opinion, however, that the development of taint can be prevented by inhibiting the propagation of these germs by immediately pumping an antiseptic solution into the bacon and hams, and for this purpose, I have found that the best antiseptic mixture consists of 55 lbs. of salt, 5 lbs. of saltpetre, and 5 lbs. of dry antiseptic (boric acid). This mixture should be made up to 10 gallons with water, boiled and stirred till clear, then allowed to cool to the same temperature as the cellar.

I am familiar with the objections which have been raised to the use of boric acid in any form, but they seem to me to be empirical to a large extent, and not possessing any real virtue—the result in fact, of mere prejudice.

Such an inhibitory solution, if injected into bacon, enables decomposition as it proceeds, to be controlled, until the tissues become saturated with a solution of the curing agents. These curing agents consist generally of salt, saltpetre, and a preservative in solution.

I have found in many cellars that the liability to taint is greatest when the atmosphere is in a stagnant condition, and thus liable to encourage the propagation of moulds and similar organisms, and it is invariably the case that when once taint attacks a cellar, it is with the greatest possible difficulty that it can be eradicated without having recourse to strong measures.

The remedy is, to clear out the cellar, and after closing up all the apertures, evaporate within it a strong volatile germicide. I have found one or two of those to be highly effective, and when evaporated, they search into the crevices of the cellar, and so destroy any germs which may be lurking there.

After this cleansing process has taken place, it is a wise thing to lime-wash the roof and sides of the cellar, and I am inclined to think that this should be done at least once a year, as there is now available a machine which enables lime-washing to be done very rapidly, and I think it ought to form an annual operation in all bacon establishments.

JAPANESE IRON AND STEEL PRODUCTION.

The great military, naval, and industrial expansion of Japan is calling for an immense quantity of iron. So far as the present developments indicate, it is impossible to provide sufficient ore from the mines of Japan and Korea to meet the expanding wants of the country. All indications point to China as a base for Japan's iron supply. The production of iron ore in Japan in the year 1905 was 126,798 tons, and of iron, 59,145 tons. For the year 1906, the production of iron from the three principal mines amounted to 40,766 tons. Judging from all present sources of information as to the existing supplies of raw material in the East, together with the future possibilities of markets, it seems clear that if there are to be any great iron producing plants established in that part of the world, they will be established in China, where iron, coal, and lime are found in great abundance, where there are apparently inexhaustible fields of coal and minerals almost untouched, and where the expanding wants of hundreds of millions of people will furnish a ready market, and where cheap and efficient labour abounds. It is impossible to ascertain the total imports into Japan of iron, machinery, &c., for military and naval purposes, but the imports of 488,434 tons of pig iron and steel, during the year 1906, together with machinery made of iron and steel to the value of £1,500,000, indicates that the total consumption of iron and steel imported for all purposes will reach an amount between 800,000 and 1,000,000 tons per annum. This consumption, against the small production in Japan, shows the dependence of the country upon foreign imports of raw and manufactured iron products. The United States Consul-General at Yokohama says in his last report, that notwithstanding the increased production contemplated at Wakamatsu and Muroran, there is every probability that there will be an increase rather than a decrease in the importation of manufactured iron and steel wares for several years to come. As mentioned above the imports of iron and steel in various forms, raw and manufactured, amounted in 1906 to 488,434 tons, and this represents the consumption in the country, exclusive of the amount produced. This consumption does not include large quantities required for naval and military purposes, neither does it include a large quantity imported in the form of machinery, hardware and similar articles. In regard to Japan's sources of supply and its demand for iron and iron-ore, an expert who was sent to Japan by prominent foreign iron interests to investigate the conditions of production and manufacture of iron in that country, stated that the iron-ore resources of that country are quite inadequate for such developments as Japan is now planning. He is of opinion that the new steel plant at Muroran will be dependent on foreign sources for its ore even more than the present plant at Wakamatsu, which draws over 80 per cent. from China. Kamaishi appears to be the only considerable source of ore, its output being smelted locally, the product amounting to about 40,000 tons of pig-iron annually. Outside of Kaimaishi and excluding Wakamatsu there are about 10,000 tons of charcoal pig-iron produced in a number of small and isolated furnaces, with ore from local deposits. These and other deposits supply Wakamatsu from 25,000 to 35,000 tons of ore annually, and the balance of the latter's plant requirements comes from foreign sources. The expert adds:—Then, in terms of ore, Kamaishi produces about 70,000 tons, and all other Japan about 40,000 tons a year. I do not expect to see any considerable increase over these figures. They may of course rise in the course of a few years to 200,000, or possibly 300,000 tons, but even the last figure is insignificant for a country with a population of 50,000,000 people. I have little doubt but that Japan will always be essentially dependent on other countries for its iron ore, and will probably continue to be for many years at least a large importer of pig iron and steel as well." A national steel foundry has been organised for the purpose of producing iron and steel at Muroran. It has the support of the Japanese Government and is expected to produce material to be used by the Japanese navy and army as well as for the general public. It is reported that a Japanese vice-admiral has agreed to accept the post of superintendent of the new works, at the same time retaining his position in the navy, and many expert naval officers are expected to assist in the construction and in the operation of the new establishment. It is expected to secure the raw material first from the iron-sand on the seashore, from the Kamaishi mines, situated 180 miles south of Muroran on the east coast of the main island of Japan, that are now producing about 40,000 tons of pig-iron per annum, and also from a deposit of brown ore near Abuta, a short distance north of Muroran. Many reliable experts, however, consider all the sources inadequate to provide even a small portion of the requirements of the works, and that ore or pig-iron required to carry on the enterprise will have to be imported from China. The cheapest and best coal in Japan for manufacturing iron is found a short distance from Muroran, and the supply is abundant.

THE TRADE OF INDIA, 1907-8.

The summarised report of the trade of India for the twelve months ended March last has just been issued in Calcutta, and reveals a large increase under most of the main heads, imports contributing no less than 9·87 per cent. of the grand total increase in trade. In respect of imports of "articles manufactured and partly manufactured," there was an increase of 18 per cent. over the previous year's figures, this being chiefly contributed by cotton manufacturers, woollens, apparel, and silk manufacturers. "Metals and manufactures thereof" showed a net increase of five million sterling, or 53 per cent. over the statistics

of 1906-7, this being chiefly made up by the imports of metals. railway material, and, in a lesser degree, machinery, hardware, and cutlery. "Articles of food and drink" displayed an increase of 9 per cent., or a little under a million sterling, sugar and salt, provisions and wheat, being responsible for most of the expansion. The group entitled "Chemicals, drugs, medicines," &c., advanced by 48 lakhs. or £320,000, of which cigarettes, alizarine and aniline dyes, and camphor formed the chief components. Oils (a most important Indian product) advanced in value from 1·85 to 2·44 millions sterling, while "Raw materials," owing mainly to advances in silk, coal, and coke, rose from £403,800 to £3,336,000 in value. The transactions in imports of treasure were, as in the previous year, of extraordinary dimensions, though the imports fell 5 per cent. owing to decline on Government account.

Exports represented more than half of the total trade and showed a slight increase of one-fifth per cent. on the figures of the previous year. Exactly the same increase is observable in the case of Indian merchandise. There are, however, some notable decreases observable. Jute exports, which in 1906-7 had for the first time exeeeded cotton in value under equal conditions. fell in 1907-8 33 per cent., while the increase in cotton represents an advance of nearly 17 per cent. Seeds, almost entirely oil-seeds, representing 9·7 per cent. of the exports of Indian merchandise, marked an advance of 2½ millions sterling or 29 per cent. on the figures for 1906-7. This export exceeds even those of 1904-5, the previous record year. Raw hides and skins, two other important articles of export, declined. Jute goods manifested expansion of 16·4 per cent., while cotton manufactures fell off to the extent of 11½ per cent., chiefly in the case of yarns, which fell by nearly a million sterling. The exports of lac continue to increase, and in the course of two years have grown by nearly half a million sterling. With regard to articles of food and drink, notable increases occurred under the head of tea, rice, coffee, wheat and wheat flour. The increase in the exports of metals and manufactures from £650,000 to £740,000 is more than accounted for by an advance of £100,000 in the phenomenal value of manganese ore. In the export of oils there has been a marked rise of some hundred thousand pounds sterling.

Exports of treasure amounted to £3,630,800, of which gold was worth about 2¼ millions and silver £1,374,200. Gold produced in Indian mines was exported to the United Kingdom to the value of £2,093,300, against £2,155,800 in 1906-7. This is sent in the form of bars to London for assay, and represent about 90 per cent. of the exports of this metal from India. The exports of silver coins, mostly Government rupees and British dollars, amounting to £1,331,100, was mainly directed to the Straits, Ceylon, Arabia, Mauritius, and East Africa.

In the re-exports of foreign merchandise there has been a rise of over 8 per cent., the largest single item in this class being, as usual, cotton manufactures, including twist and yarn. The most prominent feature, however, in the whole report is the astonishing increase in the total value of imports of merchandise, which have risen to over 86½ millions sterling or 14⅓ millions in advance of the figures for the previous year, being equal to an enhancement of approximately 20 per cent.

A GERMAN FLOWER CITY.

Erfurt, a thriving commerçial city of Southern Prussia with more than 100,000 inhabitants, is known throughout Germany as the "flower city." It has a world-wide reputation for flower and farm seeds and plants, and the exports of these articles have attained some considerable importance. The origin of the industry dates from the tenth century, and it was developed by the monks of the Peters Monastery. The growth to the present proportions, is of much more recent date. Since 1880 the business of growing flower and garden seeds and plants in Erfurt has increased rapidly, until it is now five times as large as it was a quarter of a century ago. When the land failed to produce good wine grapes, the people turned their attention to the seed industry as a means of saving their waning fortunes. In former years the hills about Erfurt and Jena were famous for their vineyards. The wine was sold mostly at Weimar, about half way between the two cities, giving this place its original name of "Weinmarkt," which was changed later to Weimar. According to the American Consul at Weimar, the soil about Erfurt is especially adapted to the culture of vegetables and plants. It is deep, rich, and well watered. The annual rainfall is heavy, and the surrounding hills afford good protection from the cool winds which sometimes sweep down from the Thüringerwald. While there are no statistics available in regard to the total annual output of the Erfurt seed and plant concerns, a single firm produces each year from 70,000 to 80,000 cyclamen, 400,000 lilies of the valley, 60,000 apple sprouts (in pots), 20,000 pear sprouts, 10,000 plum, apricot, peach and quince sprouts, 30,000 strawberry plants, 300,000 short-stemmed, and 40,000 long-stemmed roses. This firm own a dozen large hothouses and sale rooms, packing rooms, blacksmith's shop, carpenter's shop, and bindery where the cut flowers are arranged and the dried plants and mosses are put together in wreaths or bundles. Garden produce grown in Erfurt may not be peddled in the city. This business is mostly of an export nature to various parts of Germany. The annual shipment of cauliflowers alone amounts to 6,600,000 pounds. About 2,000 acres of land in the city and in the immediate vicinity are devoted to gardens. The land is owned by the Crown, the city, and by private individuals. It is leased to the various concerns at rentals depend-

ing on the position, and on the productiveness of the soil. The cultivation of the gilliflower in Erfurt dates from the year 1810. It first appeared in the window of one of the inhabitants, and from this one pot hundreds and thousands of these flowers have been propagated. The estimated annual production is 680,000 plants. To the same extent, or nearly so, is the cultivation of the calceolaria, verbena, petunia, gloxinia, pansy, carnation, balsam, hollyhock, fuchsia, &c., in almost endless variety. It is estimated that the annual output of flower seeds is not much under £50,000 in value. Vegetable and farm seeds are cultivated in large quantities and in great variety. Among them are included one hundred kinds of peas, one hundred and sixty-eight kinds of beans, two hundred and sixty-nine varieties of kitchen herbs, thirty-eight kinds of radishes, and thirty of other roots, three hundred and twenty species of potatoes, &c. There are over fifteen hundred varieties of vegetable seeds cultivated in Erfurt.

OCCUPATIONAL MORTALITY.

There has just been published a supplement to the sixty-fifth annual report of the Registrar-General of Births, Deaths, and Marriages in England and Wales. This supplementary report deals with occupational mortality, and corresponds generally to Part II. of the supplementary report which ten years ago Dr. Tatham submitted. The earliest attempt to ascertain by appeal to actual experience the various degrees of danger to life incurred by men engaged in different occupations was made by Dr. Farr, C.B., F.R S., in the year 1864, and in the three decennial supplements issued since that date the attempt has been renewed by him or his successors. The object of the present work is to furnish trustworthy material for continuing the study of the mortality prevailing among the workers in the various occupations, a study the national importance of which is now only coming to be adequately recognised notwithstanding that its value was fully demonstrated by Dr. Farr nearly half a century ago. Whether or not the results of the study of occupational mortality shall be satisfactory must, of course, depend on the precision with which particulars are recorded at the census, and in the death register, respecting the different grades of workers, but, unfortunately, the information on this point in successive census reports is not uniform.

To come to details, the comparative mortality of barristers and solicitors is lower than in any other of the professional classes except the clergy and schoolmasters. As compared with occupied and retired barristers and solicitors, law clerks experience a mortality which is higher at every stage of life. Tuberculosis, phthisis, and disease of the respiratory organs are the only causes of death that are substantially less fatal to medical men than to occupied and retired males in the aggregate. The mortality of school teachers is below the standard for all occupied and retired males at all stages of life, and is but little more than half that standard at the ages of 25 to 45 years. Musicians and music masters fare badly. The mortality incidental to this group is exceedingly high, and at each division of the working period of life the members of it die much faster than do occupied and retired males generally, but at ages below 20 and above 65 they die less fast. It is impossible, says Dr. Tatham, "to escape the conviction arrived at ten years ago, that many of the men included in this group are sadly addicted to intemperance." The life of the domestic indoor servant is exceptionally healthy, more especially that of domestic male servants, who at every age experience lower mortality than do occupied and retired males generally. Commercial travellers fall victims to alcoholism in greater proportion than do all occupied and retired males by 39 per cent., whilst their mortality from liver disease is more than double that standard. They are said to be "inordinately prone to suicide." The mortality of commercial clerks is high, and that of railway engine-drivers and stokers from accident is excessive, being 15 per cent. above the average, but from every other cause of death, except diabetes mellitus, they suffer considerably less than the average mortality. During the middle period of life the mortality of railway guards, porters, and pointsmen is below the average. The comparative mortality figure in the main working period is 19 per cent. less than the standard; from accident their mortality is nearly double. Domestic coachmen and grooms die less rapidly than do either cabmen or carriers, their mortality approximating to that of domestic servants at all ages except the most advanced. Seamen fall victims to alcoholism and diseases of the liver much faster than do other occupied and retired males. Their loss of life from accident exceeds even that of bargemen, being nearly four and a half times that of occupied and retired males generally. Both bargemen and seamen suffer loss of life at every group of ages greatly in excess of that of other occupied and retired males, the principal factor being acccident. The mortality of dock labourers throughout the main working period is considerably above the average. Among the various sections of the agricultural class the death-rates are not only below the standard for all occupied and retired males, they are also generally below the rates among all males in the selected health districts. As compared with all occupied and retired males, the death-rates of fishermen are above the standard up to the forty-fifth year of life, all between 45 and 65 are considerably below it. Publicans between the ages of 25 and 65 years show a higher mortality than any other section of the trade. Their liability to death from accident is relatively small, but the mortality from suicide is more than twice the average. Taking 11 occupations representing the class of shopkeepers at every age, the mortality is below that of occupied and retired males generally. On the other hand the mortality

from alcoholism and from diseases of the liver shows a considerable excess. Among hairdressers the mortality from alcoholism and diseases of the liver is high, being more than double the standard, whilst that from suicide shows an excess of one-fourth above. Tanning seems to be a healthy trade. At the earlier and later ages the mortality of tanners differs little from the standard, but between the ages of 20 and 45 it falls considerably below the average. The mortality of plumbers, painters, and glaziers, is very high, the excess is most marked under the heads of plumbism and Bright's disease, but there is also a substantial excess in the mortality from phthisis and diseases of the nervous system. The mortality of sawyers is the lowest in any section of the building trades. The mortality of textile dyers, bleachers, and printers in the main working period is 11 per cent. above the standard, and the mortality of glass workers exceeds the standard for occupied and retired males at all the ages of life by proportions ranging from 12 to 32 per cent. In the mining industry, as a whole, the death-rate of men under the age of 20 years exceeds by 30 per cent. the standard for occupied and retired males. At ages of 20 to 25 the mortality is normal, but from the age 25 to the age 55 it is below the standard, being in defect by no less than 25 per cent. at the ages of 35 to 45. In the main working period of life the comparative mortality figure is 11 per cent. below the standard, notwithstanding the excessive mortality from accident, which is more than twice the normal. Amongst the lead miners, the comparative mortality exceeds the standard by 20 per cent., but the mortality of workers in stone and slate quarries only very slightly exceeds the average. The mortality of general labourers is enormous throughout the whole of life. In the main working period the comparative mortality is nearly $2\frac{1}{4}$ times the standard for occupied and retired males from each separate cause of death, also the mortality among labourers is excessive, that from alcoholism and liver diseases being nearly six times and that from phthisis, from diseases of the nervous circulatory and respiratory systems, and from accidents being double the standard, while from the other principal diseases it is nearly double the standard. Although the mortality among engine-drivers, stokers and firemen is low, nevertheless it exceeds that among the corresponding workers among the railwaymen at all ages of life except from 15 to 20 years. Among chimney-sweeps the comparative mortality is above the standard by about one-third part. By far the greatest excess of mortality in this occupation is attributable to cancer, for which the comparative figure is $2\frac{1}{2}$ per cent. above the standard. Chimney-sweeps appear to be exceptionally addicted to alcoholism, and their mortality from phthisis, diseases of the nervous, digestive, and respiratory systems, and from suicide, is also high. On the other hand they appear to be but slightly liable to influenza, Bright's disease, and to accident. The comparative mortality of Civil Service messengers is 21 per cent. below the standard, and that of gamekeepers is remarkably low, being in the main working period of life 42 per cent. less than the standard.

Taking the general body of occupied males between the ages of 25 and 65 we find the mortality lowest among clergymen, priests and ministers, then come gardeners, nurserymen, seedsmen, gamekeepers, farmers, graziers, railway engine-drivers, stokers, firemen, labourers, the highest mortality being among innkeepers, publicans, costermongers, tin miners, and general labourers.

RURAL DEPOPULATION IN GERMANY.

The rapid transformation of Germany from a country where the rural villages were for centuries the principal factor, into one in which the city population is very largely in the majority, is causing both German economists and statesmen serious thought. At the present time, attention is frequently called to the necessity of administrative reforms, due to the fact that in many parts of the German Empire the rural population is becoming very small, and that practically everywhere the cities contain not only the larger part of the population, but control the bulk of the wealth as well. At the founding of the German Empire in 1871, the rural communities (those with less than 2,000 population) contained 64 per cent. of the population of the Empire. In 1905 the rural population was only $48\frac{1}{2}$ per cent. of the whole. In some districts, such as the Rhineland, Westphalia, Oldenburg and the kingdom of Saxony, the rural character of the population has nearly disappeared, the percentage of the rural population in these places being only 23, 23·5, 24·9, and 28·8 respectively of the whole population. In the kingdom of Saxony, the city population has, according to the American Consul at Annaberg, increased from 1,265,057 in 1871, to 3,211,408 in 1905, while the rural population during the same period increased only from 1,291,187 to 1,297,193. The strictly farm villages of from 100 to 1,000 population show actual decreases of from 7 to 9 per cent. for the same period. Nearly one-third of the population of the kingdom is found in the five large cities of Dresden, Leipzig, Chemnitz, Plauen, and Zwickau, and more than half the population in the cities of 10,000 inhabitants or more. In many of the suburbs of the larger cities, once purely village communities, but now swallowed up by the cities, the increase in the population for the five years from 1900 to 1905 was almost phenomenal, averaging from 75 to 80 per cent., and in some instances running as high as 200 per cent. Saxony is the most densely populated of the German States. In 1871 it had a population of 441 per square mile, and this at the last census enumeration (1905) had increased to 779 per square mile. The population of the three large cities, Leipzig, Dresden and Chemnitz was respectively 22,875, 19,842, and 15,930 per square mile. Next to

Saxony, the most densely populated parts of the German Empire are the Rhine Province of Prussia, with 616 inhabitants per square mile, and the principality of Reuss the Elder, with 577 per square mile. The average for the whole empire is 290 per square mile.

MOVEMENTS IN WAGES.

In view of the resolution of the Federation of Master Cotton Spinners Associations to reduce wages, it may be interesting to glance at the changes which have taken place in the rates of pay during the last half-century. The figures given below are largely those of tables recently published in the *Manchester Guardian*. It may surprise many to learn that wages are no higher to-day in the textile trades (including operative cotton spinners and weavers, and jute and linen operatives) than they were in 1874, although actual wages, or earnings on the whole, are considerably higher. Wages (according to rates) were calculated at the end of 1900 at 100 in a special statistical chart compiled by the Board of Trade. They remained at that figure for 1905, when they rose to 102·67. They were increased in 1906 to 106·22. Before 1900 they had never reached 100 in any year since 1877. The rate was as low as 88·01 in 1879 and 90·22 in 1885 and 1887, but in 1874 the rate of pay was 106·67, being higher therefore than it was in 1906. But probably this figure was topped in 1907—the whole particulars for which year have not yet been published.

As to list prices in cotton spinning and weaving, the operatives stand better than they have ever done since the lists were adopted. Anyway this is so in the spinning branch. In Bolton and Oldham they are paid at a rate which is 10 per cent. higher than the list prices. The economic conditions of cotton operatives are affected more by increase of spindles per operative, and speed of mules than by the wages list. Before 1907, operative spinners under the Bolton list were paid 5 per cent. above list prices from 1900. From 1890 to 1906 the list prices were maintained. From 1879 to 1889 they were 5 per cent. and 10 per cent. below the recognised standard. From 1878 back to 1858 (when the list was adopted) they were paid either at list prices or 5 per cent. above, except on two occasions, in 1869 and 1870, when they were 5 per cent. below. It is different with those working under the Oldham list. Their present figure of 10 per cent. above the standard is a remarkable change in their rates of pay. In 1906 they were 5 per cent. above the list, from 1900 to 1905 they were paid on the list prices. From 1876, however, when the list was adopted, until 1900, they were from 5 per cent. to 20 per cent. below the recognised scale.

In the weaving section of the cotton industry the operatives were paid from 10 per cent. to 15 per cent. below list prices from 1878 to 1898. From 1899 to 1904 7½ per cent. below, in 1905 2½ per cent. below; and in 1906 the list prices were reached. The Blackburn list (by which weavers wages were regulated and which was changed into the uniform list in 1892) was framed in 1853. Weavers were paid list prices from 1853 to 1877, except in 1869, when they were 5 per cent. below, and in 1860 when they were 5 per cent. above. These list prices held their own in some of the worst periods of the cotton industry, including the cotton famine consequent upon the American civil war. The rates of pay have shown an upward tendency since 1899 and are now at the highest point in the history of the trade in cotton spinning.

In 1905 changes and rates of wages in the textile trades affected 311,437 work people, mainly in the cotton trade, representing a net increase of £9,900 per week, or about £500,000 a year, or £1,500,000 less than was lost in wages in 1903, to say nothing of the huge loss in 1904. In 1906 rates increased to the extent of £12,943 per week in the wages of 402,497 operatives, or about £660,000 per year, or, taking the two years together, £1,600,000, nearly £900,000 less than the losses in 1903 alone. If the aggregate increase of wages obtained in 1907 is added to those of the two previous years they hardly equal the reductions sustained by the operatives through short time in one year alone of the slack period from 1902 to 1904.

FLUOR SPAR.

The greatly enhanced use of fluor spar as a flux in metallurgical works during the last few years has led to great development in the mining of the mineral, and it may not be without interest to say a few words on the subject, more particularly with regard to Derbyshire, where the augmentation in the output is so striking. Although fluor spar, which is the fluoride of calcium, is found to some extent in other geological horizons, it is nowhere so abundant as in the carboniferous limestone and its associated Yoredale beds, and the whole of the present British production comes from these strata, where it is found as the gangue of metalliferous veins. It is usually associated with calc spar, quartz, or barytes, though this is not universally the case. The present importance of the mining industry will be at once apparent when we compare the output of only a few years ago with the figures for 1906, which are the most recent ones available:—

	Tons.		Tons.
1898......	56	1903......	11,911
1899......	783	1904......	18,160
1900......	1,448	1905......	39,446
1901......	4,214	1906......	41,849
1902......	6,287		

Uutil 1902 the bulk of the output came from Durham, from the mines of the Weardale Lead Company, but since that year Derbyshire has gone rapidly ahead, and Durham now takes the second place.

This has been brought about chiefly through the working of the old lead mine dumps, in which the fluor spar exists as the waste material from lead mining operations dating from remote times. When the exploitation of these dumps was commenced four or five years ago a great show of secrecy was made about the proceedings, and but little information was obtainable as to the destination and uses of the wagon loads of mineral sent off from Hassop and Hope Stations. At the present time the mystery has been dispelled to a great extent, and it is known that the stuff which has been so largely shipped to America from Liverpool is valued for its contents of fluor, and not for any precious metals. At the present time there are about twenty workings for fluor spar in Derbyshire, and, with the exception of one or two at Ashover, in the isolated mining district to the east of the county, these are all in the northern district, Great Longstone, Eyam, and Bradwell being the principal points of activity. The great master vein on Longstone Edge, known in the west as the High Rake, and in the east as the Deep Rake, is a considerable producer of fluor spar, which is now being got from virgin ground as well as extracted from old dumps. From veins closely associated with the Deep Rake, it is also being got notably from the Salad Hole (originally spelt Sallet) mine and the Red Rake mine. The High Rake has yielded large quantities of lead ore in the past, a good deal from open surface workings, the vein being in places as much as 14 yards in width In the Eyam district the old mine heaps on the great vein which runs nearly east and west from Tideswell Moor to Eyam are being exploited, more particularly at the Eyam end, where four or five workings are now in progress, the most accessible of which is at the old Glebe mine dumps, close to Eyam church. At Bradwell, nearer Castleton, considerable activity is being displayed by the four firms engaged in the fluor business ; and what with this, the resuscitation of lead mining, and the quarrying and mining of calc spar and limestone for certain industrial purposes, the place seems likely to regain its erstwhile importance as a mining centre. Until recently the bulk – in fact, practically all—the fluor spar has been got in Derbyshire from the old mine dumps, an operation which cannot be called mining, being merely an elaboration of the "hillocking" which has for long been carried on for fluor and barytes by miners working on their own account. It is certain, however, if the present demand continues—and there seems little doubt of this—that regular mining will be more and more entered upon, as the hillocks or dumps, cannot, of course, be considered inexhaustible. Indeed, in one or two cases already the fluor is being mined for, specially where the prospects of finding lead also seem favourable, and in this connection the Red Rake mine at Calver and the Nunley at Bradwell may be mentioned. It will be recognised, no doubt with envy by lead speculators in other British districts, that where the gangue is saleable it is possible to drive levels and open stopes in search of lead at no loss, even if the metal is present in unpayable quantity. With regard to royalties and mineral rights, special conditions obtain in Derbyshire dating from very early times. Matters, however, having become somewhat chaotic, the existing laws were revised by Parliament in the middle of the last century, the result being the High Peak "Mining Customs and Mineral Courts Act of 1851" and the "Derbyshire Mining Customs and Mineral Courts Act of 1852." In these Acts the local customs and quaint phraseology of early times are to a great extent preserved, and we still have the bar-master and jurymen as important personages in the "nicking" or taking up of a mine, while the dishes and loads of ore remain as measures of volume and weight. Not to enlarge too much on this topic, it is important to note that while the lead ore is now the property of the Crown in the King's field, its associated gangue belongs to the lord of the manor. Although most of the dumps have been nicked as lead mines, and figure as such in the bar-master's books, very little revenue has so far accrued to the Crown, or, more precisely speaking, the Duchy of Lancaster, the royalties on the fluor spar going to the landowner, with whose interests the bar-master is not concerned. With regard to values, it is noticeable that in the Home-office "statistics" the Derbyshire output was valued at £1 per ton four years ago, and in 1906 at 10s. per ton. These figures, however, must be taken with a good deal of reserve, the spar being by no means uniform in quality, the large clean crystalline blocks being superior to the smalls which form a considerable part of the output. Moreover, considering that at some of the dump workings a mixture of fluor with calc spar and other minerals is sent away to be more carefully separated elsewhere, it is clear that the valuation given can only approximate to accuracy. There are one or two other points in the "statistics" which seem open to question, but they hardly call for notice in a general article like the present.

Glancing now at Durham, we find that the whole of the output of fluor comes from the neighbourhood of Weardale. It has been mentioned that Durham now comes second to Derbyshire in point of output, but the great spurt made in 1906, and more recently, indicates that the industry will be a permanent and increasing one. Although one or two other firms are also engaged in the business, more particularly as regards old mining dumps, the principal producer is the Weardale Lead Company, at whose various mines fluor spar is a regular vein stuff. The fluor is by no means confined to the main limestone from which the bulk of the lead ore is at present being obtained, but is being mined of exceptional purity in the hazle or sandstone beds between the main limestone and the Tyne bottom limestone. As a producer of best quality fluor in bulk, the Sedling mine of the Weardale Lead Company is in the front rank. For some time the mineral was obtained mainly from the old

dumps, but these are now exhausted, and the present production comes entirely from the mine. The Sedling vein, which is a right running vein 8 ft. to 15 ft. in width, is now being worked at a depth of 70 fathoms, the winding of the ore being effected by a water wheel, an interesting survival of old practice. Habitués of the Jermyn-street Museum are doubtless familiar with the fine crystallised specimens of fluor spar which have come from Weardale, and though, of course, the district has been specially favoured by Nature, the writer has been much impressed by the interest taken by the local mine agents and miners in the subject of mineralogy, compared with what he has found in various other lead-mining districts. The occurrence of fluor spar in Weardale having recently been dealt with by Mr. W. M. Egglestone in a paper before the North of England Institution of Mining and Mechanical Engineers, we do not propose to say anything further on the subject, and pass on to remark that in Teesdale the lead mines have only yielded fluor in insignificant quantities, and no working of it is on record, a remark which applies with equal force to Swaledale and Wensleydale, further south, where lead mining was once such an important industry.

It will be of interest now to glance for a moment at other countries. Although we are not in possession of detailed figures, it is apparent from the latest statistics that the rise of fluor mining into prominence in England has been reflected in such foreign localities as produce the mineral. Roughly speaking, the American output has increased at about the same pace as our own, and is now at somewhere the same figure. Kentucky has achieved the first place as a producer, and it is followed by Illinois, Tennessee, and Arizona. On the European Continent the mineral is by no means widely distributed, in the well-known mining districts at any rate; it is, however, now being obtained in France, Saxony, Bavaria, and Spain, though in small amounts compared with England and America. In view of the fact that America is now shown to be posessed of so much fluor of her own, it seems rather strange that the British export should continue; it does continue, however, with which categorical statement the inquisitive must rest content. Apart from a certain employment in glass and enamelling works, and in the preparation of hydrofluoric acid, the bulk of the present production of fluor spar is used as a flux in the metallurgical industries. It is now some ten years since it came into regular use in Germany in connection with the ferro-manganese and ferro-silicon manufacture, and this practice is now general in England and America. It enables a fluid slag to form at a low temperature, and also reduces the sulphur and phosphorus contents. It has also an increasing application in foundry work, and altogether there is little reason to condemn the optimism of those who see a great future for the mineral when its potentialities become even more widely recognised than is the case to-day. Purity is, of course, a matter of importance, especially freedom from silica, and careful selection of the mineral as it comes from the dumps or the mine is made before it is offered for sale. This naturally means that considerable variations in price are to be met with. An impurity which has to be specially guarded against is galena, the lead ore with which the fluor is so intimately associated in the mine. Although it is freed as much as possible from it, the sellers of fluor spar refuse to give any guarantee as to its absence, and it is probable that but few shipments are entirely free from it. With regard to what is, perhaps, the most generally known form of fluor spar, it may be mentioned that the greatly increased production of which we have spoken has not affected in any way the artistic business carried on at the famous Blue John mine at Castleton, Derbyshire, where the fluor has unique characteristics. In conclusion, we may say that fluor mining, depending so much on the iron and steel industry, is in a somewhat stagnant state at the present time, and, owing to the accumulation of stocks, there is no immediate prospect of a return to the activity of two years ago.—*The Engineer*.

GERMAN KIESELGUHR.

Kieselguhr, or infusorial earth, is used as filling material for soap, sealing wax, paints, and colours, and for the manufacture of dynamite, aniline, and alizarin, water glass, cement, mortar, artificial stone, gutta percha and caoutchouc articles, and for a variety of other purposes. It is found in considerable quantities in Hanover. It is a light flour-like mass—grey, brownish, or light green—feels soft and dry to the touch, absorbs water, and in ordinary temperature resists chemical action. It is found in layers in alluvial soil, or in the vicinity of lignite deposits. Large quantities exist near Huetzel in the Lüneberger Heide, and also near Unterluess in the same part of Hanover. The kieselguhr extracted at Huetzel is dried only in the open air, and it is generally cleaned before being used. Kieselguhr is also found near Vogelsberg in Hessen, at Jastrabe in Hungary, near Franzensbad in Bohemia, in Tuscany, Sweden, Finland, and also in Canada. The principal characteristics of kieselguhr are the low specific weight it has, which is ·250 to ·550, the high absorption, and its quality of being a very bad conductor of heat, making it one of the most reliable means of protection against the radiation of heat. The method of extraction is similar to that of clay for the manufacture of bricks. The product is removed from the open pit, and then spread upon benches, or hill sides, for the purposes of drying by air or sun. Artificial drying processes—by means of hot air—in rooms, drums, or troughs, have not, it is said by the American Consul at Hamburg, proved practical in Germany. Kieselguhr roasts easily, but must never be brought into contact with a flame, as it would soon calcinate. The drying of kieselguhr in ovens would

not be profitable, and such process would never come into consideration in large concerns. Several processes of drying kieselguhr, by using mechanical means, have been tried in Germany during the last twenty years, but have not proved satisfactory, and have therefore all been discarded. Kieselguhr has also been dried by means of hot air and exhausters, but this process is one applied only, in wet weather, in exceptional cases, and with material which has already been dried to a certain extent. This process, however, is not remunerative, and can only be applied with the best quality of kieselguhr—washed for the manufacture of dynamite—and at a time when the market is at a high level. It has to be taken into consideration that kieselguhr contains, as it is extracted, 70 to 90 per cent. of water, which evaporates very slowly. Air-dried kieselguhr still contains from 15 to 25 per cent. of water. After having been dried, it is ground, and packed in sacks. During transportation, special care is taken to protect the product against moisture. For crushing mills, there are four different systems in use in Germany.

EMMANUEL SWEDENBORG.

The Academy of Sciences of Stockholm have undertaken to do honour to the genius of Swedenborg by the publication of his scientific works. The movement now on foot to honour the memory of Swedenborg on account of his great scientific attainments had its beginning outside of his native country. Dr. Max Neuberger of Vienna in 1901 delivered an address before the assembly of German Naturalists and Physicians, entitled "Swedenborg's References to the Physiology of the Brain." In this address Dr. Neuberger pointed out some of Swedenborg's most important conclusions in the field of cerebral physiology, in which he was far in advance of his time, and anticipated many modern discoveries. The address concluded with the warmest expression of appreciation of the great genius of Swedenborg in this field of research, and the opinion was expressed that "this man, during the scientific period of his life, exhibited a penetration in various fields of research that is nothing less than magnificent."

Following up this interest in Swedenborg, Dr. Neuberger addressed a communication to the Academy of Sciences of Stockholm, in which he expressed his regret that Swedenborg's extensive manuscript on the brain, which is preserved in the Library of the Academy of Sciences, had not yet been published. This led to the appointment of a committee to investigate the matter. Professor Dr. Gustaf Retzius, the chairman of the committee and president of the Academy, made a study of the subject of Swedenborg's physiological treatises. The result of this study he presented before the Congress of Anatomists at Heidelberg, May 29th, 1903, in his address as president of that body.

The committee of the Academy of Sciences now made a thorough examination of the manuscripts of Swedenborg, all of which had been deposited in its library by his heirs. This investigation brought to light a remarkable array of scientific and philosophical works, many of which had never been published. They covered many fields of scientific research and included treaties on mathematics, chemistry, metallurgy, magnetism, ontology and cosmology, geology, palæontology, psychology, anatomy, and physiology.

Dr. Retzius became so impressed with the value of these works that he proposed to the Academy of Sciences to issue an edition of Swedenborg's scientific and philosophical works, and offered to bear the expense of the first three volumes himself. The first volume of this series has lately been issued from the press. It contains Swedenborg's contributions to geology and a number of his letters. The preface is by Dr. Retzius, and Professor Alfred G. Nathorst, palæontologist and geologist, has written the introduction, in which he gives an analysis of Swedenborg's contributions to geology in that early stage of the science, and gives him high praise. Volume II. will contain treatises on chemistry, physics, and mechanics; and volume III. on cosmology. Four other volumes are planned, two on the brain and two on general physiology.

The Swedish Government requested of the British Government permission to remove Swedenborg's remains to Sweden, which request being granted, a war vessel was despatched for the purpose, and the body was transferred, with appropriate honours.

A number of different movements in Sweden have been instituted with relation to Swedenborg and his works. One of these is to be the establishment of a museum which shall preserve original portraits of him, his relics, and his works. The librarian of the Stockholm Academy, the institution that possesses his manuscripts, has planned a Swedenborg room to contain these and other Swedenborgiana. Besides this there is the resumption of the publication by a photographic process of fac-similes of the manuscripts. This movement by private subscription resulted in the publication of ten volumes about thirty years ago. Three splendid volumes in the new series have just issued from the press.

Although many of Swedenborg's treatises have remained unpublished during a period of one hundred and seventy-five years, some of the most important of them were published by Swedenborg himself in Latin and have been translated into English. A new edition is now being prepared and published by the Swedenborg Scientific Association of America.

This attempt to revive the fame of Swedenborg as a scientific discoverer, taken in connection with the removal to Stockholm of his body from the Swedish Lutheran church in London, is a very remarkable instance of the revival of interest in the man of science as distinct from the founder of a Church.

Swedenborg died at the house of a peruke maker in Great Bath-street, Cold Bath-fields, in March, 1772, and was buried at the Swedish church in Prince's-square, St. George's-in-the-East.

RUBBER PRODUCTION IN THE CONGO FREE STATE.

According to the latest statistics, the world's production of rubber for the season 1905-6 was about 68,000 tons, of which 41,000 tons were produced in Brazil. Bolivia, Central America, and Mexico gave a combined total of 1,800 tons, Africa 23,400 tons, and the balance came from Asiatic countries. Of the amount obtained in Africa, the Congo Free State gave the largest quantity with a production of 4,500 tons, French Guinea 1,500 tons, Angola 1,250 tons, and the Gold Coast 1,000 tons. These figures are for the fiscal year ended June 30. The Congo Free State is producing and exporting, on the average, a little over 4,800 tons of rubber annually. For the calendar years 1904, 1905 and 1906, the exports were 4,830, 4,861 and 4,848 tons respectively, valued at £1,769,000, £1,759,000 and £1,950,000. For the year 1907 the figures are not yet available, but the American Consul at Boma hears on good authority that they will vary but little from those of the preceding years in the quantity produced. The market, however, has been less active during the closing months of the year, and the average price received during 1907 will doubtless show a decided falling off from the exceptionally high prices of 1906. Various causes are assigned for this. A steady increase in the world's production, and recently of stocks on hand; the monetary crisis in the United States; the difficulties in which a large number of automobile manufacturers have become involved through overproduction, with the consequent lessening of the demand from this industry, one of the largest consumers of rubber, are a few of the reasons given. One authority has stated that the large production of Mexican guayule rubber was the basic factor in the recent sharp decline in price, and early recovery to the high level of the past three years was not probable, owing to the unusually large output, by improved machinery, of the Mexican product, which was of good quality, and practically inexhaustible. A Brussels paper recently called attention to a statement by a German authority in which quite the contrary opinion was expressed, it being affirmed that the hopes entertained as regards the guayule rubber had not been realised. While the annual exportation from the Congo has shown no diminution during the past few years, there is no question but that in many parts of the State the supply of wild rubber has rapidly diminished, and in a large part of the territory is practically exhausted. This condition, it is said, is in a large measure due to the ruthless cutting of the vines and trees by the native gatherers, a method which insures a quicker and more copious flow of the latex, but which entirely destroys the plant. The law provides that the rubber must be gathered by means of incision of the vine or tree, thus preserving them for future supply, but in practice it is impossible, except in a small way, to control and enforce this wise provision over the immense expanse of territory producing rubber. To counterbalance this continual lessening of the supply of wild rubber, the State has enacted laws, obligatory alike upon its own agents and the concessionary companies, providing for the replanting of vines and trees, the number of plants corresponding with the quantity produced. Thus at present, for every ton of rubber gathered the producer must lay out five hundred young plants. It has been proved by experiment that the variety of rubber tree, known as the "Funtumia Elastica," thrives better under cultivation in the Congo Free State, and gives much quicker results than the various varieties of vine rubber. The quality is said to be excellent and the young trees become paying producers in about seven years. Ordinarily, quite double this time is required before the vine yields in sufficient quantity to be profitable. At present it is estimated that fully 13,000,000 plants have been set out, capable of producing within a few years and at a low estimate 650 tons annually. Independently of this the State has established three great centres of rubber cultivation, each of 250,000 acres. These centres have been established in the Mayumbe district near Banza (Lower Congo); in the Ubangi district, near the post of Duma; and in the Lualaba-Kasai, between the posts of Katako-Kombe and Lodja, in the forests of the Upper Lakenie. A calculation made of the probable production of these centres alone shows that one-third of the area allotted, or 250,000 acres, will be planted during the next six years, with an average of 260 plants to the acre, or a total of 65,000,000 plants. When the entire area of 75,000,000 acres provided for, is planted, the yield after six years is expected to be 9,750 tons annually, or nearly double the present production, and this without calculating the 13,000,000 trees already started, and the number constantly being planted under the terms of the law.

REFRIGERATING CONGRESS.

The first International Congress of the Refrigerating Industries (Congrès International du Froid), will be held in Paris, from Monday, October 5, to Monday, October 12, at the Sorbonne. The Congress will be divided into six sections—I., Low Temperatures and their general effects; II., Refrigerating Appliances; III., Application of Refrigeration to Food; IV., Application of Refrigeration to other Industries; V., Application of Refrigeration in Commerce and Transport; VI., Legislation. At the opening meeting Professor von Linde will deliver a lecture on "Refrigeration in Dwelling Places," and at the closing meeting a lecture will be delivered M. d'Arsonval on "Liquid Air and very Low Temperatures." A British Programme has been issued by the British Committee (3, Oxford Court, Cannon Street, E.C.), containing a list of British Papers and Resolutions. The honorary secretary is Mr. R. M. Leonard.

In addition to the general visit to Fontainebleau

during the Congress, there will be three extended excursions—I., October 13 to 17, to Compiegne, Pierrefonds, Reims-le-Grand, Vignobles de Champagne, Mézières, Longwy, Nancy, and back to Paris; II., October 13 to 22, Roquefort, Causses du Taru, Nimes, Marseilles (International Electrical Exhibition), Lyons, Creusot, and back to Paris; III., October 13 to 25 (1), Paris, Laiteries co-operatives des Charente et du Poitou, (2) Paris, Bordeaux, Biarritz, Bayonne, Fontarabia, Saint-Sébastien, Pau Cambo, Lourdes, Paris.

MOTORING IN GERMANY.

According to official statistics just published, there were on January 1, 1908, in the German Empire, 36,022 motor vehicles, of which 34,244 were passenger vehicles and 1,778 were carriages for the transport of goods. This is an increase of about 33 per cent. during the year 1907. Of the passenger vehicles 19,575, or more than half, were motor bicycles. The increase was much larger proportionally in South Germany than in North Germany, being but 17·2 per cent. in Prussia as against 84·8 per cent. in Bavaria and 148·1 per cent. in Hesse. The American Consul at Annaberg says that in the city of Berlin the increase in the number of motor vehicles for the year was only 6, or 0·2 per cent. Of the passenger vehicles, 14,046 were used for business or professional purposes, and 13,771 as pleasure and sporting vehicles. During the year 5,686 motor vehicles passed the frontier for temporary use for touring purposes in the Empire. Statistics as to accidents due to motor vehicles are given for the year from October 1, 1906, to September 30, 1907, during which time there were 4,864 such accidents, in which 145 persons were killed and 2,419 injured. The figures for the dead do not include those who died after the accident as a result of their injuries, but only those killed on the spot. The proportion of accidents to the number of machines differs widely. In the province of Brandenburg, in which is the city of Berlin, there are 5,275 motor vehicles, and during the year there were 2,554 accidents involving such vehicles—about one accident for every second machine. In Berlin itself it came close to being one for every machine. In the Rhineland there was one accident to every twenty machines; in Prussia as a whole, one to eighteen, and in Bavaria, Saxony, Wurtemberg, and Baden it varied from one accident to every ten machines to one to every eighteen machines. It must be noted that with the vehicles mentioned are reckoned the motor bicycles, which cause few accidents, but which constitute more than half the motor vehicles in Germany. In 4,598 cases of accident, *i.e.*, 95·5 per cent. of the total, the owner of the vehicle causing the accident was identified, and in 266 cases the owner remained unknown. Punishment by fines and imprisonment, or both, was imposed in 1,406 cases; in 1,092 cases through judgments by the courts, and in 314 cases by summary fines imposed by police officers and collected on the spot.

ARTS AND CRAFTS.

Arts and Crafts at the Exhibition of the International Art Congress.—Had any proof been needed of the importance of the Arts and Crafts movement, not only in our own country but throughout the Continent, as well as in the United States, it would have been amply furnished by the work shown at the Exhibition, until recently open at South Kensington, in connection with the Third International Congress on the Teaching of Drawing. Of course, the greater portion of the available space would be taken up by exhibits which referred only to the teaching of drawing as a part of the regular curriculum in elementary and secondary schools, and a considerable amount of room was devoted to fine as opposed to applied art; but the exhibits which have to do with industrial art, and more especially with that branch of it which we usually indicate by the title of "Arts and Crafts," not only formed a very considerable part of the show, but a much larger and more varied one than would have been the case, say, ten or fifteen years ago. Moreover, considering the relative difficulty of packing and transporting ceramics, wood work, metal work, embroidery, and other such things, it is remarkable how much executed work had been brought together at South Kensington.

It is, of course, quite impossible to judge, from an Exhibition of this kind, to what extent the teaching of design, of industrial art, or of arts and crafts is carried in the various countries represented. It is difficult, too, to make comparisons since some countries exhibit on a much larger scale than others, and, moreover, it is generally on occasions like this, the smaller or more backward nations who find it best worth their while to make the biggest effort to show what they can do. Still, bearing these facts in mind, and realising the limits within which its lessons hold good, there is a certain amount of information to be obtained from the Exhibition, not only as to what is being done throughout the civilised world, but as to the general direction which design teaching is taking in the different countries, and such information is both interesting and illuminating. To begin with, it is remarkable that the exhibits of some of the most important industrial and manufacturing countries were, at first sight at least, amongst the least attractive and even the least interesting. Close examination reveals the accuracy and perfection of the drawing of the French designs, and the careful training which is evidently bestowed upon the student designer. Some of the work from the United States (though not by any means all of it) is thoroughly business-like in its presentment, and the drawings sent up from one school are models of what such work should be.

There is also a good deal of quite adequately executed work from Germany. But it is not in the exhibits of the large and important countries that the interest of the Exhibition, so far, at any rate, as design and handicraft are concerned, lay. It was to

be found, rather, in the work which came from Switzerland, Holland, and Austria, all of which lands exhibited on a large scale, and showed work which, while not always, perhaps, in all respects as good as that which came from the larger and more important countries, is in some ways a good deal more interesting, and vastly more suggestive, from the point of view both of art and of education. It would be quite wrong to argue from this fact that the work being done in these countries is better than what is being produced elsewhere, but it does at least show that such places are doing something in the way of education in art and handicraft which is at once interesting and instructive—something which may make us, even in England, pause and think.

Switzerland.—The room which contained the Swiss exhibit of art and handicraft was, perhaps, the most interesting place in the Exhibition, and the work shown is mainly remarkable as combining a very high standard of technique with a reasonable amount of ingenuity and invention. We are apt to look upon Schools of Arts and Crafts as institutions where, too often, the art has to make up for rather primitive craftsmanship. That does not seem to be the Swiss idea at all. In the *Kunstgewerbeschulen* of Zurich and La Chaux-de-Fonds the students are evidently encouraged in a very workmanlike manner of work. It is possible, of course, to condemn some of the metal work as trady, and it may be lacking, indeed, in some of the qualities to be found in the metal work turned out by schools nearer home, but it is, at any rate, possible that if Switzerland has something to learn from our methods, we may have a good deal to learn from hers. Again, the careful drawings produced by the embroidery students for even quite simple needlework are in very marked contrast to the practice which obtains in some English schools; but if the Swiss embroidery shown is not particularly remarkable, neither is it the kind of work which can be lightly dismissed as "shoppy" or as lacking either in taste or in individuality. If it is wanting in anything, it is, perhaps, distinction, a quality which, however desirable in itself, is hardly to be insisted upon in work executed by students in a school of handicraft. The batik work, again, is extremely good, and exhibits a far greater command over the process than usually characterises such work, whether on leather or textile fabrics. One feels that the element of fluke, which plays so important a part in some batik work, has been here reduced to proportions which bring the process well within the range of practical politics. The enamels, though artistically they are not of very great value, show a really wonderful mastery of technique.

The Swiss work may not be altogether what we should wish to be turned out by our own schools, but it is, at any rate, in its own way, excellent, and suggests an ideal of technical school work by no means to be despised. Students who can do this kind of thing may not be, probably are not, artists, but they ought to be able at all events to earn an honest living as craftsmen.

Holland and Austria.—The Dutch and Austrian work is, as a whole, far more amateur than the Swiss—some of the productions might even be called amateurish. For all that, both these countries have sent very interesting shows. The needlework in the Dutch section proves that the simple, rather geometric, work, which has been shown at recent exhibitions is, at any rate now-a-days, being taught in the schools, and with admirable results. The practice of encouraging or allowing students to execute designs in stencilling or painting, and then to outline them with stitchery or with couched silk or cord, is, on the other hand, open to considerable objection. The simple, low relief, wood-carving shown in this section suggests how useful a knowledge of this elementary kind of work might be to the carpenter or joiner, and how easily it might be acquired. The Dutch designs are mainly interesting as showing how persistent the influence of the so-called *art nouveau* is in Holland. In most countries it is by this time dead—and we might almost add buried—but in Holland, if it is not exactly flourishing (and one could quite well believe that it is) it has, at all events left a very decided mark on the work being turned out by the schools of art and handicraft.

The Austrian exhibit made the visitor open his eyes, he might even want to rub them after he had looked at it awhile. The arts and crafts show was supplied by the Imperial Royal School for Arts and Crafts of Vienna, and included, amongst other things, some interesting pieces of enamel, some in the more usual kinds of workmanship, others in *plique-à-jour* and in wire on filagree enamel more or less of the Hungarian type. There was also a fair-sized collection of metal work and, finally, two or three window-cases containing the special class for art weaving. The work in this section is very pleasant in colour, and pains seem to be taken to teach students how to restore Oriental carpets and gobelins. It appears sound policy, too, to teach those who wish to weave and especially to restore old woven fabrics something of the properties of the dyes used for textile fabrics. The ribbon plaiting, simple as it is, is sometimes very charming in effect. This kind of work is admirably adapted to the belts, children's hoods, reticules, &c., for which it has been used.

Lettering.—Several countries showed good lettering. There was practically nothing which compared with the script which is being so well taught in our own schools, but some very good and very vigorous lettering was exhibited. One or two pieces in the Swiss section were really excellent. The ornamental writing from Vienna, again, was wonderfully interesting. If it is at times a trifle extravagant, that is quite compensated by the variety of styles shown. These students are evidently encouraged not only to do one particular kind of writing well, but to practice writing

and lettering in various styles suitable to a variety of different circumstances. From Holland, Germany, the United States, and other countries, came writing and lettering in no small quantities—a remarkable proof of how the study of this subject has gained ground in recent years. The schools took some time in waking up to a sense of the dignity of lettering, but it would seem that now, not only in England, but all over the civilised world, its importance to students of handicraft and of industrial design is being amply recognised.

OBITUARY.

SIR GEORGE BARCLAY BRUCE. — Sir George Bruce, the eminent engineer, died on the 25th inst. after a long illness, at his residence, 64, Boundary-road, St. John's-wood. He was born on October 1st, 1821, the son of Mr. John Bruce, of Newcastle-on-Tyne. About the age of 16 he entered the works of Robert Stephenson, at Newcastle, and while there he had to do with the manufacture of engines for the London and Birmingham Railway. He was engaged on the construction of the North-Eastern Railway, and was resident engineer of the Royal Border Bridge at Berwick, for the construction of which, under Robert Stephenson, he was responsible. He received in 1851 the Telford medal of the Institution of Civil Engineers for his paper on the bridge. He saw also the inauguration of the Indian railway system, and for many years he was chief engineer of the Madras Railway. He took the chair at a meeting of the Indian Section on March 29th, 1889, when Sir Juland Danvers read a paper on "The Progress of Railways and Trade in India." In the discussion he gave some of his experiences of Indian railways, and said that he remembered the old days of travelling, when the maximum of luxury was 2½ miles an hour in a bullock carriage. Sir George Bruce was knighted in 1888, was President of the Institution of Civil Engineers from 1887 to 1889, and was elected a member of the Society of Arts in 1876.

GENERAL NOTES.

TOTAL PROHIBITION IN FINLAND.—In his report on the trade and commerce of Finland (No. 4079 Annual Series) Mr. Consul C. J. Cooke refers to the action of the Finnish Senate in the proposal of laws relating to alcoholic liquor, and the total prohibition thereof. This prohibition, the Consul points out, will not only ruin the trade and manufacture of such liquors, but also, in an important degree, affect Finnish mercantile relations with the Powers. There is considerable import of alcoholic liquors from several countries, and prohibition will probably cause the exporting countries to make objections, and might even bring about serious relations with regard to Finnish export. To prevent such eventualities it will be necessary to revise several commercial treaties with the countries interested; but to do this the aid of the Russian Government must be invoked. Meantime excessive drinking appears to be on the increase in Finland. The number of persons taken into custody by the police of Helsingfors in 1897 was only 4,910. In 1906 it had increased to 12,118.

COST OF LIVING IN PERU.—For Europeans the cost of living in Peru is high, and is increasing rapidly. Referring to the point, Mr. Jerome, Acting British *Chargé d'Affaires* at Lima (No. 4074, Annual Series), says that the common commodities of the country have, for various reasons, trebled in the last five years, having risen 65 and 100 per cent. in the same period. Imported commodities, which to the European forms the bulk of his more ordinary necessities of clothing and even food, cost four times their ordinary retail prices in the United Kingdom, and, together with the very high rentals of dwellings possessing the hygienic requirements of Europeans, added to the small purchasing power of money, make high salaries rather a delusion. In Lima, a small apartment of two or three rooms rents on an average for £4 per month, and an independent dwelling, with five rooms, including kitchen and offices, for £7 per month, while a small, moderate house of ten rooms, with modern conveniences, will often fetch from £20 to £25 and more per month, in all cases unfurnished, and not including rates and taxes.

MANUFACTURED TOBACCOS IN GERMANY.—How greatly German Customs duties restrict trade with the United Kingdom is illustrated by Colonel Brookfield, His Majesty's Consul at Dantzig. Reporting on the trade of the district (No. 4071, Annual Series) the Consul says that the Customs duty on imported tobacco for pipes and cigarettes was formerly a little over 9½d. per pound. It has now been raised to 3s. 1½d. per pound for fine-cut "cigarette tobacco," and in addition to this enormous tax, all imported "cigarette tobacco," and cigarettes are subject to what is called a banderole tax, which varies according to the retail price. British tobacco manufacturers have tried to meet this difficulty by importing their finest and best known "smoking mixtures" in a coarse cut form, but this makes the old brands hardly recognisable, and in short, not only is it now made almost impossible to introduce this article at all, but when it is introduced it has to be in shape which is bound to prevent its being properly appreciated. At the same time there is little doubt that thousands of Germans who have everywhere given up the old German pipe in which they used to smoke coarse-cut tobacco, would be very glad to smoke English best fine-cut tobaccos instead of cigars if they could only obtain them at a reasonable price, and in the form in which they are sold in the United Kingdom.

Journal of the Royal Society of Arts

No. 2,911. VOL. LVI.

FRIDAY, SEPTEMBER 4, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

"OWEN JONES" PRIZES FOR INDUSTRIAL DESIGN.

This competition was instituted, in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Committee of the Owen Jones Memorial Fund, being the balance of subscriptions to that fund, upon condition of their spending the interest thereof, in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual national competition of the Board of Education, South Kensington.

Six prizes were offered for competition in the present year, each prize to consist of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the Grammar of Ornament, by Owen Jones, and the Bronze Medal.

The following is a list of the successful candidates:—

Bloor, Herbert H., School of Art, Macclesfied. Design for a Woven Silk Hanging.

Clowes, William, School of Art, Macclesfield. Design for a Tapestry Hanging.

Cundall, Charles E., School of Art, Manchester. Design for an Earthenware Pot in Silver and Ruby Lustre.

Paul, Silas, School of Art, Leeds. Design for a Wrought Iron Grille with Lamp.

Reburn, Lilian, School of Art, Manchester. Design for a printed Silk Hanging.

Wilson, Robert D., School of Art, Nottingham. Design for a Stencilled Hanging.

The next award will be made in 1909, when six prizes will be offered for competition.

THE EGYPTIAN COTTON INDUSTRY.

While closely resembling each other in many of their characteristics, and constituting a well-defined type, at least from an agricultural and commercial point of view, several well-marked varieties of cotton now exist in Egypt. At the present time, the varieties that are chiefly grown are Ashmuni, Mit Afifi, Jannovitch and Abbasi. Ashmuni is the oldest of the four varieties, and was formerly the most widely grown, although now largely supplanted by more valuable kinds. The Mit Afifi, in acreage, and the total value of its product, far exceeds all the other varieties. At least 70 per cent. of the total Egyptian acreage in cotton is of this variety. In 1906, 75·5 per cent. of the total crop was Mit Afifi, 15 per cent. Ashmuni, 5·5 per cent. Jannovitch, and 2·7 per cent. Abbasi. Mit Afifi resembles the Ashmuni variety in so many ways, that, according to a recent report by the Bureau of Plant Industry of the United States Department of Agriculture, it is likely to have originated directly from the latter. The Jannovitch is the most recent variety that is extensively grown. It is said to have developed, about thirteen years ago, as a cross between Mit Afifi and Gallini. The Abbasi much resembles the American Sea Island varieties. Very recently a variety known as Nubari has originated in the Nile Delta. It is described as intermediate between Mit Afifi and Jannovitch, having stronger and more lustrous fibre than the former No country in the world appears to be better adapted than Egypt to growing cotton. The long, hot, rainless summers, deep alluvial soils, plentiful supply of water for irrigation, abundance of cheap labour, facilities for economical transportation to the best markets, and last, but not least, the possession of distinct and very valuable types of cotton, form a combination of conditions for the production of this staple, that is well-nigh unrivalled.

Agricultural Egypt consists of the long narrow valley, and the broad fan-shaped delta of the river Nile. In the Nile valley, south of Cairo, about 2,300,000 acres are under crops, while, in the Delta, where nine-tenths of the cotton is produced, there are 3,400,000 acres of cultivated land. All of this land is under irrigation, the rainfall being wholly

inadequate for crop production. The importance of thorough preparation of the land before planting cotton is fully appreciated in Egypt. Cotton roots descend deep into the soil, and it is found that the deeper the ploughing has been the better the plants withstand drought in the case of shortage of irrigation water. On large estates steam ploughs are generally used, and the soil is turned over in the autumn to a depth of twelve inches. The great bulk, however, of the cotton acreage is worked with the primitive plough of the country, drawn by a team of oxen, which loosens the soil to a depth of only about six inches. When the operations of ploughing are completed, the land is at once ridged. Ridging is done, usually, with the native plough, the width of the furrow being increased by stuffing sacking or some other bulky material into the angle between the beam and the share. The ridges are then shaped into beds by men working with the "fass" or short-handled hoe, a tool that is indispensable to the Egyptian agriculturist. Planting is done chiefly in March, although, especially in southern Egypt, it is sometimes begun as early as the 10th February. There is a general conviction in Egypt that early planting gives the best results. Cotton is planted closer than in the southern United States, notwithstanding the fact that the plants of Egyptian varieties make a larger growth than American upland varieties. The average distance between the rows is only about two and a-half feet, and the "hills" are usually fifteeen or sixteen inches apart in the rows, with two plants in each hill. Hence the average number of plants to the acre is about 26,000. Seed is planted at an average rate of one bushel and a-quarter per acre. It is put in on the side of a furrow, about two-thirds of the distance from the bottom. In planting, a man with a "fass," or short-handled hoe, goes up and down the rows, making holes at intervals of fifteen or sixteen inches. He is followed by a boy who drops into each hole eight or ten seeds, covering them to a depth of two or three inches. Usually ten or twelve days are required for germination. A watering is usually given immediately after planting, although sometimes the field receives an irrigation just before planting is begun. The second irrigation generally takes place about thirty-five days after planting. It is found that the best results are obtained if this watering is postponed as long as can be done without injury to the plants. This causes the roots to strike deep into the soil from the outset, stimulates the plant to branch from the base, and prevents the lower part of the stem from making a soft and weak growth which is later unable to hold up the weight of bolls. From twenty-five to thirty days elapse between the second and third irrigations, and about twenty days between the third and fourth. The fourth usually occurs some time between May 20 and June 1. Thereafter until the end of August two waterings monthly are generally given. When the Nile is very low, however, it is sometimes necessary to increase the interval between irrigations to three weeks, and to restrict the amount of water that can be applied each time. Altogether, ten irrigations are commonly given between the date of planting and that of the first picking, care being taken so to time the last watering that the soil will become dry before picking should begin. A watering is given as soon as the first picking is completed, and often one between the second and third pickings. Cultivating is performed entirely by hand in Egypt, even on the large estates where modern machinery is used in other agricultural operations. On well-managed farms a boring is given as soon as the plants are well above ground. It is considered desirable to thin the rows before the second watering, which, as stated above, is given about thirty-five days after planting. The two strongest plants are thus left in each "hill." When the soil has dried sufficiently after the first watering that follows planting, the second and third hoeings are given. The hoeings are so managed that earth is each time brought up around the plants from the opposite edge of the furrows, which are thus gradually moved in one direction across the field. Consequently the plants which at the outset stood on the slope of the furrows at the edge of the beds, are at the top, and in the centre of the beds by the time the third hoeing is completed. Cotton-picking begins in Southern Egypt before the end of August, but in the Delta region, where the bulk of the crop is grown, the first picking generally commences about the beginning of September. A second picking is made in October, and a third in November. Sometimes a fourth picking is made, while occasionally the whole crop is harvested in two pickings. It is considered especially important with Egyptian cotton to begin picking as soon as enough bolls are ripe to make it worth while, since long exposure to the sun is said to cause the brown colour to fade. As a rule, 35 per cent. of the total crop is harvested at the first picking, 45 per cent. at the second, and 20 per cent. at the third, but these proportions vary considerably from year to year. The fibre from each picking is graded and marked separately, that from the first picking being generally the best, and that from the third picking the poorest. This work is done largely by children, who pick on an average 30 to 40 pounds of seed cotton a day, for which they are paid at the rate of ninepence to tenpence per hundred pounds. The seed cotton is packed in sacks holding about 400 pounds, and is then ready for shipment to the ginnery. The product is generally sold where it is grown as seed cotton, and is transported by the buyer to one of the ginneries which are established in various parts of the cotton-growing region. Most of the establishments have a large number of gins. Some of them have a daily capacity of 300 Egyptian bales. As in the case of Sea Island cotton in the United States, the roller gin alone is used, since the saw gin employed for American upland cotton injures the long staple Egyptian varieties. The ginned cotton is shipped, usually in

rough bales, to Alexandria. There it passes through compresses, and is turned out in the neat bales bound with eleven hoops, in which Egyptian cotton reaches the European and American markets. These bales, although smaller than the average American compressed bale, weigh from 700 to 800 pounds. The cotton production of Egypt is large in proportion to the area usually devoted to this crop, which, duing the four years from 1903 to 1906 averaged 1,500,000 acres. Practically the entire crop, both lint and seed, is shipped to Europe and America, so that the statistics of exports fairly represent the total production of the country. For the nine yearly period, ended 1906, the average annual export of cotton was about 612 million pounds. Assuming that the area in cotton during these years averaged 1,500,000 acres, the yield per acre for the whole country during the period was about 408 pounds. When carefully chosen seed of good varieties is used, and the soil and cultural conditions are favourable, yields of 800, and in exceptional cases, of even 1,100 pounds of cotton are obtained. In the year 1907 the quantity of cotton exported from Egypt amounted to 679 million pounds. About 50 per cent. of the exports go to the United Kingdom. The United States takes large quantities, ranking third in the list of importing countries in 1902 and second in 1903. Russia, Austria, France and Italy also import certain quantities of cotton. Nearly all the principal countries in Europe obtain cotton from Egypt, and even India and Japan receive some of the product.

RUSSIAN PORCELAIN, 1744-1908.

An *edition de luxe* in a truly magnificent sense of the word has recently been published by the Russian imperial porcelain factory. Unfortunately, with the exception of one chapter in French, the text of the work is in Russian, which makes it available for only a limited number of readers. As there is no scarcity of illustrations, however, both interspersed in the text and in the accompanying plates, the book should find numerous friends among lovers and collectors of old and new porcelain. The coloured reproductions of the Petersburg porcelain works alone make the work valuable, if not indispensable, to every collector, while its service in deepening and increasing the understanding of the Petersburg porcelain as a whole is by no means slight.

As the story of Russian porcelain is not widely known, an attempt will be made here to give a brief sketch of its history. This will help to a better understanding of the modern commercial china of Russian manufacture, which is finding much favour in this country (America), and which it is the purpose of this article to lead up to.

Beginning with the eighteenth century, says *Die Kunst*, porcelain began more and more to be used in Russia. Well-to-do circles followed the example of the Imperial family and all kinds of table ware became popular. Chinese porcelain was brought by caravan and through West-European ports, whilst the products of Venice, Rouen, and Holland also found favour.

Peter the Great conceived the double plan of taxing this importation and of benefiting his land by native industry, and as a result sent Russian workmen abroad and imported foreign ones to introduce the manufacture of porcelain into Russia. A "Board of Manufactories," founded in 1723, promised an Imperial bounty to anyone who would found a porcelain factory, material for which was to be furnished by the clay of Gjel. Grebentchikow, purveyor to the Empress, secured the privilege, but it was not until 1747 that the Grebentchikow factory, the first of its kind in Russia, was able to send to the Emperor a fairly successful "real Russian porcelain cup." In the same year new experiments were made at Tsarskoe-Selo, by command of the empress, after a workman from the imperial Chinese factory was supposed to have been bribed into selling a special secret, but the efforts did not meet with much success on account of the material and bad instruction.

No more fortunate were other, immediately succeeding, attempts to establish a native porcelain manufactory in Russia. In 1744, Christopher Conrad Hunger, in Stockholm, was engaged by the imperial court at a high salary to found a factory in Russia. Hunger, however, was an adventurer, and more than 10,000 roubles were paid him with no returns. In the autumn of 1746 he had not yet produced a single object, and in 1748 he was sent home. Thus we have seen that in the first four years the attempts failed utterly.

In 1747, Winogradow became director of the factory and proceeded by his own experiments to discover what material was best suited for his purposes. His porcelain had at first a bluish tone, and was somewhat transparent. In 1748, a large kiln was built; the experiments were successful, and in 1751 it was possible to present the empress with a snuff box, as a result of which the whole Court ordered porcelain snuff boxes from the Imperial factory. Unfortunately, the rapid development of the latter was hindered by Winogradow's bibulous habits, although the factory did continue to progress gradually. Winogradow's advice to train young apprentices for the work proved to be very practical, a fact which is worth notice to-day. His efforts to find good earth were also noteworthy.

In the swampy vicinity of Gjel he found eight different kinds of clay. Of these he selected a "black," which when dry became light gray, and when burned was pure white. This clay itself had no sulphurous component, although the layers surrounding it were mixed with earth containing much ferriferous sulphur.

Winogradow had been told by a traveller in China that there the porcelain clay and the glaze

were produced wholly from potter's earth and stone, but he could not proceed on these directions, as he had no material at hand like the Chinese kaolin or pé-tun-tze. Winogradow added to his mixture only gravel, alabaster, quartz, and feldspar of granite; gradually he came to a composition of eight parts clay, eight quartz, and one alabaster. His proportions thus resembled much more closely the Chinese and Japanese porcelains than those of Sèvres or Meissen. The glaze was composed of clay, quartz and chalk. Its thickness equalled that of two sheets of paper. Before burning, the porcelain was placed in the kiln in cases. The production of suitable colours offered many difficulties; cobalt, gold, purple, black, red, yellow, green, and brown were used.

Public taste was raturally determined by that of Western Europe. The style followed was the modern, already introduced into France, which no longer had anything to do with the profuseness of the rococo. Snuff boxes in the form of sealed envelopes were an especially popular object of manufacture after 1753. Soon flowers and garlands in flat relief ornamented the cups, and in 1752 statuettes are mentioned in the records for the first time.

A new epoch in the history of the factory began with a visit of Empress Catherine II. in July, 1763. At that time 104 officials and workmen were connected with the factory, which after 1765 had a yearly subsidy from the Government of 15,000 roubles. Joseph Regensburg was summoned from Vienna, and Karlowsky from Meissen was installed as sculptor, although they were soon replaced by Russian artists. Tchépotiew, the new director, rendered especially valuable services by establishing a school of young workers. His successor, Prince Wiazemsky, likewise introduced far-reaching reforms after 1773.

The sculptor, J. S. Rachette, was engaged in 1779, and was of the greatest help to the factory. The miniature painters of this period were Russians like Zakharow, Wassiliew, Konarow, and others. The output increased enormously; in 1794 about 60,000 roubles worth of goods were sold.

In spite of all this the financial result could not be called hopeful. Russian ceramics, indeed, offered no competition, and the Chinese imports suffered from the emigration of the Chinese from Kaichta, but preference was given to the Meissen porcelain, which was cheaper and more elegant. The composition of the material more and more resembled Chinese mixtures rather than those of Berlin and Vienna, although the clay of Glukow had now been selected for use and the alabaster was replaced by feldspar.

The unpronounced style in vogue was plainly a hindrance to the popular recognition of the products of the imperial factory at the time of the Empress Catherine. Popular taste was ruled from France—the Empress wished to give her porcelain a truly Russian character. Although time and technique, however, were not ripe for her endeavours, the factory did nevertheless bring out a very characteristic product in a charming series of statuettes showing Russian racial types.

An occurrence of still greater importance was the production of a table service of 973 pieces for sixty covers. This is known as the "Service with the Arabesques" of 1784.

Emperor Paul I. had a great fondness for porcelain and was very proud of his "factory." Rachette, the talented artist, was continued as directing sculptor, while Zakharow looked after the painting. In spite of technical and artistic progress, however, material results did not follow. In 1801, 14,000 roubles' worth of goods remained unsold. Hence it was a very timely idea of Nicholas I. that the imperial factory ought to be supported by the State, since it was there to serve as a model to the nation by producing the best ware.

As the clay of Glukow did not give satisfaction, and was besides too expensive, clay from Limoges began to be used after 1836, at least for smaller objects. Now for the first time (1834) the burning was done in a three-storied kiln after the Berlin model, which Seyffert had introduced under Alexander I. The degrees of heat in the three storeys were 160, 100, and 60 respectively. The loss in the kiln of larger vases also became less. A permanent exhibition room was established and the results of exhibitions in St. Petersburg (1849), Moscow (1843 and 1853), and London (1851) showed that the pursuit of one object for more than a hundred years had not been in vain.

Unluckily, this time—as on so many previous occasions—success came but fell upon unfavourable conditions. The technique of the imperial factory had developed extraordinarily, but artistic appreciation for porcelain had diminished throughout Europe. The evil eclecticism of the time produced a mixture of models and drove porcelain painting into strange channels.

Thus the forms deteriorated into a mixed style, which even the technique of the porcelain often enough seemed to disown. As there were no original designs in the porcelain painting, this epoch was without artistic importance for Russia—as for the whole of Europe. The general lack of interest in porcelain as a whole was only the final consequence of this artistic retrogression. In 1870 the purchases by both private individuals and archdukes had so fallen off that the decline of the imperial factory could not be denied.

In 1871 the Empress ordered the workmen to follow English styles of ornamentation, and the models which the sculptor Spiess brought from England were slavishly copied. It is precisely in his works that the lack of any feeling for ceramic form is very noticeable.

Even in the eighties, when Archduke Vladimir Alexandrovitch had reorganised the factory, the unfortunate belief still held sway that all that was necessary were good copyists, not great artists. As regards technique, however, a better understanding

had been reached. In 1884 the technician Khowansky made the first journey to gain a thorough acquaintance with the porcelain factories of Prussia, Saxony, Bohemia, and France. The result was the demolition of the old kilns and the building of new ones, after the systems of Berlin, Sèvres and Meissen.

Although the tradition of imitation was not yet broken with, and although independent technical experiments were not allowed, yet the purely empirical testings were now and again replaced by an analytical procedure and a more exact calculation of the possibilities resulting from the combinations of soil.

The personal taste of Alexander III. could hardly be called promotive, yet in this period of preparation falls the attempt at least to paint under glaze, which system the Danish painter Lusberg desired to introduce. There seemed on the whole, to be some desire to follow new technical aud artistic paths—but the tradition of imitation was less troublesome. This should be taken to heart by our "modern" devotees of tradition.

Under the rule of the present Czar things were at first no better. Gradually, however, the new art movement made headway in Russia also, but more slowly than in Germany, and under more unfavourable conditions.

With the beginning of the new century, unity of form and ornamentation were set up as the standard. The idea of the inventive artist was given room to expand, but the artists who invented were wholly inexperienced technically, which resulted in the sad makeshift of the purchase of artists' designs to be altered at need and used by art workers in ceramics.

The style of the eighteenth century has disappeared even in Russia. The history of the imperial factory shows in an exceedingly interesting fashion, the final victory of practice over theory and imitation, the victory of technique over mere dallying with form. It is true that seldom is the history of a manufactury so full of blunders and mishaps as that of the imperial porcelain factory of St. Petersburg from 1744 to 1904. As a whole, however, the detailed account, with its wealth of public economic as well as public Russian sidelights, furnishes to organisers of art workshops a zig-zag row of signposts, which easily mark the straight path for him who can survey the detours.

What has been most remarkable, however, from the point of view of china for commercial purposes, is the progress made by the factory of Kornilow Bros., located at Poliustrovo, in the district of Viborg, right on the outskirts of St. Petersburg.

This firm started in 1781 as a china and glass store. In 1835, Michael Kornilow, long possessed with a desire to manufacture his own goods, obtained a number of hands from the imperial factory and started, with two kilns and eighty workmen, the manufacture of china after his own ideals.

The kaolin used comes from Glotchoff in the government of Tschernigoff, and the quartz and feldspar comes from Finland, with clay of Borovitschi, in the government of Novgorod.

At present, the firm of Kornilow Bros, is managed by Serge Michaelovitch Kornilow, one of Russia's most enterprising business men, an eminent chemist and a practical potter in every sense of the word.

The factory covers thirty-five acres of ground, has eight kilns, and employs 600 workmen. Mr. Kornilow is a business man possessing advanced and original ideas.

So much has been said in regard to the poor condition of the working-classes and the masses generally in Russia, it is only fair that a tribute be paid to him for the manner in which he looks after the welfare of his working people. He has built for them on grounds adjacent to the factory many modern, sanitary houses; he has given them the use of a magnificent park, and has also built at his own expense a large and handsome theatre, where the workmen and *employés* render some very interesting plays under the patronage and encouragement of the firm.

As far as the ware produced in concerned, it has probably the hardest body of china made, wood being exclusively used in the process of manufacture. Furthermore, it is also possibly the whitest and purest quality of china made.

As far as the decorations are concerned, they are so thoroughly Russian that they have really created a new school in art decoration. The blending of the colours is particularly a happy one, and it seems that some of the colours used in this ware cannot be put on any other body of china giving the same effects. Expert connoisseurs have said on different occasions that the Kornilow products are among the most remarkable and artistic novelties produced for a long time.

While the productions of the imperial factory are not for sale and are only distributed to foreign sovereigns as gifts from the imperial factory, it is most fortunate that goods so essentially Russian and so thoroughly artistic can now be procured in nearly every high class store in this country. The demand for Russian china has increased tremendously in this country, and now the fashionable hostess takes a distinct pride in garnishing her table at large dinner entertainments with pieces of ornate decoration.—*Pottery and Glass* (New York).

INDIA'S TRADE IN 1907-8.

(II.)

The grand total of imports and exports combined was $230\frac{1}{2}$ as against 212 millions sterling in 1906-7, the increase being one of $18\frac{1}{3}$ millions, or 8·7 per cent. This includes some $2\frac{1}{2}$ millions sterling of foreign merchandise re-exported, but excludes about 1·8 millions of material imported by Government for State railways.

Particulars of the import and export trade were given in the article in the *Journal* for the 29th August. The value of the trade of India in merchandise only, excluding Government transactions, with (1) the United Kingdom, (2) other British possessions, and (3) foreign countries may now be recorded.

The trade with the United Kingdom has increased by £8·2 millions, the share of the home country having slightly risen from 42 to 43 per cent. of the total trade. This increase was produced by a rise of £9·7 millions in the imports, the exports from India declining by some £1·3 millions.

The trade with British possessions other than the United Kingdom was less by £656,000 than in 1906-07. Here again there was a rise under imports into India, but a decline of £1,453,000 under exports therefrom.

Trade with foreign countries has increased by over 7,000,000 sterling, and represents 43·9 per cent. of the total trade, the imports having increased by 4,000,000, and exports by 3·2 millions sterling. Viewing the trade with each principal country, the order of precedence is Germany, China, United States, Belgium, France, Japan, Straits Settlements, and Austria-Hungary. But until the returns are compiled, according to the true country of origin, so far as imports are concerned and country of final destination for exports, the figures can only be regarded as a rough and ready index of the trend of trade. Japan, Belgium, Holland, Java, and South America showed considerable advances. With China and the United States there was a marked shrinkage in trade due, in both cases, to fall in exports from India. Germany has advanced, both under imports and exports, by five and six points respectively. The shares of Belgium and Japan rose from 4·1 to 5·3 and 5·1 per cent. under exports, Java improved under imports from 2·7 to 4·5 per cent., but Austria-Hungary reduced her share of imports from 2·8 to 2 per cent. The other countries have not shown any marked change. Taking the trade of each province by sea with foreign countries, and comparing imports and exports together, Bengal stands first with 39.95 per cent. as her share of the total, and Bombay second with 30·49 per cent. Then follow Madras, Burma, Sind, and Eastern Bengal and Assam in the order named. It must be explained, however, that while each province manifested a substantial increase in imports, averaging 20 per cent. all round, Bengal and Eastern Bengal and Assam showed diminished exports.

The exports from Bengal are chiefly jute, raw and manufactured, the latter being practically a monopoly of the province, tea, raw hides, opium, rice seeds, lac, coal, and indigo. From Bengal and Assam the principal exports are raw jute and tea. From Bombay raw and manufactured cotton; Madras opium, oilseeds, wheat, and raw wool. The exports from Sind are raw cotton, hides, wool, seeds, and the bulk of the wheat shipments. Madras commands a very large share of the trade in tanned skins, her other principal exports being raw cotton, coffee, rice, and oil seeds. The export trade of Burma is almost confined to mineral oil, rice, teak wood, raw cotton and hides.

PRICES AND SUPPLIES.

The Board of Agriculture and Fisheries has just issued that portion of the volume of the agricultural statistics for 1907 which contains information relating to prices of agricultural products, supplies of live stock at markets, and imports and exports of agricultural commodities. For the first time since 1898 the average price of wheat exceeded in 1907 30s. per quarter, while barley and oats were higher than in any year since 1902. The increased dependence of the population upon imported food is concisely shown by a comparison of the quantity per head annually received for a series of years. In 1859-65 we imported 126 lbs. of wheat and flour per head; in 1901-7 the figures had risen to 294 lbs. In the same period the total crop of wheat in this country fell from 112 lbs. per head to 75 lbs. Even assuming that the whole of the home crop was actually available for food (which in view of the requirements for seed and other purposes is not the case) four-fifths of the wheat consumed in the United Kingdom is supplied from abroad. In the case of another important article of diet, potatoes, the position is very different. The period of maximum imports was in 1873-9, when 23 lbs. per head were received. In 1901-7 imports were only 18 lbs. per head. The oversea supply still represents only a small fraction of the total consumption, but the figures seem to indicate that potatoes may be regarded as forming a somewhat less important item in the national dietary than formerly. The greatest relative increase in imported supplies appears in the case of meat. The imports of beef and veal have increased from 3·3 lbs. per head in 1859-65 to 22·6 lbs. per head in 1991-7. Imports of butter and margarine have increased in the same period from 3·5 per head to 6·7 lbs. per head, whilst the growth of the trade in imported eggs may be gathered from the fact that the number imported per head of population has risen in the same period from only 8 to 53. The total expenditure per head of population upon wheat, meat, butter, cheese, eggs, fruit, and vegetables, has risen in the same period from £1 2s. 2d. to £3 4s. 11d.

The arrested progress of imports of live animals for food, to which attention was drawn in the last report, became a decline in 1907. On the other hand, there was an increase in the amount of dead meat brought into this country, the record quantity for 1907 being exceeded by 300,000 cwts., the greatest increase being in fresh beef. The larger quantities of dead meat sent from British possessions, more particularly Australia and New Zealand, in 1907, more than compensated for the reduction in foreign supplies,

due mainly to the decrease in the consignments of the United States. Tables given in the report show that in 1907 there were imported 115,636,564 cwts. of wheat and flour. These quantities represent an increase of over four million cwts. of wheat as compared with 1906, with a decrease of nearly 900,000 cwts. of flour, so that the net augmentation of wheat, including flour, over 1906, was a little over three million cwts. The proportion of imports of wheat and flour sent to us by foreign countries was nearly 64 per cent. in 1907.

GERMAN VIEW OF ENGLAND'S INDUSTRIAL POSITION.

Dr. Walther Rathenau, of Berlin, has lately published an important work, entitled "Reflexionen" (Leipzig: S. Hirzel, 1908), which has attracted much attention in Germany. His remarks upon the present industrial position in England, translated from this book, are here printed. Dr. Rathenau accompanied the Colonial Minister, Count Demburg, in his tour of German East Africa, last year, and he is a leading member of the Berliner Handels Gesellschaft.

The Englishman, well-to-do, healthy and muscular, loves work, but will not sacrifice himself for it. He demands his week-ends, his evening hours, country life, and sport. The German loves his work above everything, and is insatiable in his demand for knowledge, and where the love is lacking, an inflexible conscientiousness secures his performance of duty.

The German is now so far "Yankeefied," that he adopts all improvements, which seem at all reasonable, without waiting for the mathematical certainty that they are to be successful; but the English are conservative to a degree, and keep asking, "Will it pay?" till their plant is obsolete.

The trades union is a heavy drag on the wheels of English industry. The English workman does not dream of a future international brotherhood, but rather sets his heart on the immediate improvement of his surroundings, and he has already succeeded in realising his dream to such an extent that the manufacturers are merely tools in his hands. The trades unions prescribe how many, and which, workmen they must employ, and what they must pay; which things may be made on piecework, and the rate to be paid for them. They allow, or prohibit, the introduction of labour-saving machinery, and the specialising and enlarging of the business.

Probably the German Socialists would be pleased if they possessed the same power, but this they will not easily obtain, so long as they strive merely for big election figures and the shadow of political influence. Anyone starting a new industry in England to-day will find himself in a tight corner. Materials are plentiful enough and means of transport are sufficient, but the difficulty is to get good technical men. German schooling, learning, and practice are not to be had, and what is obtainable costs quite as much as the best German quality. The English business man works at least one-fifth shorter time than the German and costs one-third more. The Englishman is capable enough, but will do only what is established practice, anything complicated or extraordinary he declares impossible, and so long as the business goes well he is pleased with himself, but when it goes badly he lays the blame upon his employers or somebody else. In England the general business expenses are exorbitant, and what remains over is, in many cases, swallowed up by the Board of Directors or manager.

These things may be seen by everyone who studies industrial England to-day—a factory which might be taken for a model is scarcely to be met with. The mighty union of elementary industries working together under one roof to the production of one finished product from the various raw materials, so common in America and Germany, may be sought for in vain in England. The textile industry is still, perhaps, an example to be followed, but that is more for mercantile than for industrial reasons. The enormous coal business is conducted with the most primitive plant, and the technology of metals is not to be compared with that of Germany or America.

The chemical industries are not to be compared with those of Germany, because English science has not had the power to direct the innumerable streamlets of the black art into the river of technical knowledge, and because the industry has not understood how to draw supplies from the army of learning which German technical high schools yearly recruits. In electrical technology the case is similar.

There can be no doubt that the English quite clearly understand their position in the international race of industry. The unfriendly feeling towards Germany has its origin only in the rivalry of workshop and arsenal.

The reasons for the English industrial backsliding are serious, but instead of taking big measures to improve matters, a system of tinkering was undertaken; first came the "Made in Germany" law—as one knows, a big mistake. What was intended to be the skull and cross-bones on the poison bottle, became at once the hall-mark of honour, and the Colonists soon learned the true source of supplies. The next attempt was the introduction of a sort of protective tariff in the awakening of "national feeling," which has resulted in placing a direct £ s. d. value on patriotism, and at the same time increasing the anti-German feeling when Town Councils have to throw over cheap German tenders in favour of dear English ones.

But even the ideal Protection will not be enough to bolster up permanently English industries. An English protective tariff cannot last, first, because although a young plant may be strengthened by being placed in a hothouse, the same treatment would only weaken and destroy a forest tree. Moreover a protected English industry cannot reconquer the

world's market. The battle of the world's market is to him who is up-to-date and progressive in technical science. Before everything Free Trade is a necessity for the trade metropolis and the trade monopoly of the earth.

I believe that England may safely sacrifice her industry for her trade. The geographical, economic, and cultural mission of England is to be mistress of the seas, the fair and market-place for all lands, the Rialto of the world. On this account agriculture has already been sacrificed, and rightly so; industry, or more correctly, the place in the world's industry, will follow, and yet England will become the mightier in her old calling.

There are people here in Germany, and elsewhere, who believe that England is an island about as big as France and as thickly populated. No! that island kingdom is nothing less than the market of the whole world, and the Government House of a full third of the inhabited globe. If, in this vast palace, here and there something is hammered, cast, boiled or spun, it is really of little consequence. We others are hand-workers, who live by work. They live by ruling and protecting.

COTTON MILLS IN GERMANY.

The following abstract from report of Special Agent W. A. Graham Clerk to the Bureau of Manufactures, Washington, D.C., is taken from the American Journal *Cotton* (Atlanta):—

In the manufacture of cotton goods Germany holds third place, being only exceeded by the United Kingdom and the United States. In the exports of cotton goods Germany is only exceeded by the United Kingdom. Raw cotton is the largest single import of Germany, and manufactured cotton the largest export. In 1907, the average value of the cotton imported was 12·14 cents per pound, and the average value of the manufactured product was 63·84 cents per pound.

Cotton manufacturing is an old industry in Germany, and before the introduction of machinery there were well-known centres of weaving, knitting, braiding, lace making, &c., in Saxony and on the Rhine. The German people were slow to avail themselves of the introduction of modern machinery, so that many local hand industries were stifled by the flood of machine-made goods from other countries, and for a long time Germany obtained the bulk of its cotton goods abroad, mainly from England. The unification of the German Empire in 1870 awakened the national spirit, and, encouraged by a firm central Government, there began an agitation for the manufacture of cotton goods at home. The 1,500,000 spindles taken over with Alsace-Lorraine put the German industry ahead of the French, and this lead was further widened by the increased momentum in the cotton-manufacturing industry about 1879. Since then there have been no very remarkable spurts, but a gradual and steady growth.

Saxony is the leading German State in cotton manufacturing, and has nearly trebled its spindles in the last twenty years, but its increase has been even greater in special lines like those of knitting and embroidering.

Mulhausen in Alsace is the most important town in Germany as regards spindles and looms. Nowhere in Germany is the cotton industry better organised than at Mulhausen, and this place has become noted for its fine muslins and print goods. One of the main products of this place is a fine cotton print known locally as a 75/26 print, but which would be called in the United States a 24/26 print—that is, with 24 warp and 26 filling ends per $\frac{1}{4}$ inch. These are made 31 to 32 inches wide, and some of them are exported to the United States.

Chemnitz stands twelfth in number of spindles, but is one of the most important cotton manufacturing towns in Germany. Its importance is due to the fact that it is the centre of the German knit goods manufacture. Plauen is a town with no spinning and few looms, but is also an important cotton-manufacturing centre, owing to its etched lace and embroidery work. Very little machine-made lace is made in Germany, but the largest factory of this kind is at Dresden. Barmen, in the Rhine Province, is noted for its braided work and for its manufactures on the ribbon loom. Crefeld is noted for its velvet manufacture and velvet dyeing; Elberfeld for its dyeing; Munchen-Gladbach for its coloured goods, &c.

Comparatively few of the German mills have both spindles and looms, and in the big centres the mills specialise on either spinning or weaving, as is the custom in England. The more remote mills in the country sections of Alsace and the Rhine usually weave their own yarns.

The following Table shows the status of the German cotton manufacturing industry at the end of 1905, giving the details of the industry in each State:—

States.	Spinning mills.	Spinning and weaving mills.	Weaving mills.	Spindles.	Looms.	Bales of cotton consumed.
Saxony	96	7	54	1,968,580	39,236	388,085
Bavaria...........	16	13	53	1,577,632	31,092	300,000
Alsace	16	32	43	1,536,562	39,919	240,000
Westphalia ..	17	18	36	1,456,636	25,729	255,300
Rhine Province	42	24	21	1,275,355	24,408	287,090
Wurtemberg ...	11	17	148	761,440	19,352	115,000
Baden	10	13	28	526,804	16,744	80,134
Hanover	1	7	18	225,000	5,024	48,425
Silesia	9	5	45	133,930	16,540	28,315
All others	7	6	47	268,270	13,155	19,020
Total	225	142	493	9,730,209	231,199	1,761,369

There has not been a Table made up by anyone since 1905, though the president of the German section

of the International Federation of Master Cotton Spinners' and Manufacturers' Association estimates that on March 1, 1908, there were in Germany 9,592,855 spindles in operation, and 455,946 being installed, or a total of 10,048,801.

The most important cotton mill, though not with the largest number of spindles, in Germany, also the best paying, as shown by its published dividends, is the Augsburg Mechanische Baumwoll Spinnerei und Weberei at Augsburg, in Bavaria. This mill has 126,940 spindles running on average No. 17s English, and 2,920 looms, of which 520 are on bleached goods, especially printers, and 2,400 on heavy gray goods. It employs 3,000 operatives. The mill was founded in 1837. The dividends distributed by this mill to its stockholders for the seven years ended with 1906 were, in consecutive order, 20·4, 14·6, 16, 23·5, 17·5, 23·5, and 28 per cent., or 143·5 per cent. in the seven years.

Heating and ventilation in this mill is carried on by means of flues built in the wall, the air going up the flues on one side and being drawn down to the basement again through the flues on the other side. Separate dressing-rooms with clothes lockers are provided for the men and women on each floor. There is also provided a large hall with tables and chairs, where the operatives can eat their lunches. Coffee and milk is sold in the morning, hot soup at noon, and beer at four o'clock. Until 1906 this mill ran an 11-hour day, but it then changed to 10 hours. This 9·1 per cent. decrease in time was followed by a 7·85 per cent. decrease in production.

In regard to wages at this mill, the picker room hands and the carders get 50 to 70 cents a day; on two 900 self-actor mules the spinner averages about 90 cents a day. Weavers, on an average, run three looms apiece, and make about 80 cents a day; 170 of the looms have the Northrop attachment. At this mill a man is supposed to serve a two-years' apprenticeship before he can do as simple work as that of running three looms on plain goods. He has to sign a two-years' contract to this effect. He first works as extra assistant to a weaver for six months, then he is given one loom, which is run under the supervision of the regular weaver, who received a certain percentage on the wages made. Then he is given two looms under the same conditions, and it is not until the new weaver has been working for two years that he is considered a full-fledged weaver and allowed to enjoy the fruits of his labour without division. During the first six months the mill usually pays the apprentice 24 cents a day.

After all this elaborate apprentice system it is doubtful if the weaver is as good as the young American weaver who comes in from the farm, and in a few months at most is getting off the required production along with the others. All fines and penalties are paid to a sick fund. Besides the regular Government insurance, this mill has special insurance funds of its own for the relief of the sick, for old age and invalid pensions, for the relief of widows, &c.

The pension fund of this mill provides a pension, after twenty years of service, equal to 30 per cent. of the annual wages; this is augmented two per cent. every year up to 40 years service when it is 70 per cent. It is then augmented three per cent. per year up to 50 years when the worker is entitled to a pension equal to his regular wages. Except in special cases, a worker is not accorded a pension until he has reached the age of 50 years.

BRAZILIAN ORCHIDS.

So far, there has been no great volume of exports of live plants of various sorts from Brazil, although there is a constant but small business in the export of young palms and palm seeds. As regard orchids, there are a number of firms operating in the several coast ports of the country, buying plants as they may be secured in the interior, and selling them as opportunity occurs, generally at the present time on a commission and consignment basis. From time to time several of these firms send men into the interior to secure specimens, but at present most of the goods are coming down to the coast apparently as a result of previous work on the part of the orchid hunters. One of the leading houses making a specialty of orchids has had for some time, a man in the interior ranging over a wide stretch of country. His work has been very successful, and the shipments of his orchids are conducted on a large scale. According to the American Consul-General at Rio de Janeiro, most of the orchids taken in the past have been shipped to England, where there are many important houses carrying on a world-wide business in such plants alone. The increased interest in them in the United States, has followed largely from European interest. While the plants are somewhat difficult to handle with safety in a commercial way, there is comparatively little loss from damage in transit. Sometimes the plants are packed in baskets, an average of about one hundred in each. Other firms ship them in specially constructed cases with much larger lots in a case. The number of the finer and rarer varieties secured and shipped is comparatively a small item in the trade, the standard varieties forming the last bulk of the business. There are over six thousand varieties of orchids recognised and described by the authorities in the Botanical Gardens of Rio de Janeiro. A very large portion of this list of plants is composed of varieties which have little or no value. Some varieties are very common, while a great many of them are rare enough to command from £3 to £10 in Brazil. Other varieties are very rare, and the value of specimens is mostly fixed by what collectors will pay for them, varying greatly from time to time. Probably three-fourths of the business, in value, may be said to be in less than a dozen varieties of the plant.

HOME INDUSTRIES.

The Cotton Trade Crisis.—The outlook in the cotton trade has not improved since the last reference in these Notes to the wages dispute. On August 19 the Emergency Committee of the Federation of Master Spinners met to receive a report on the ballot of the general body of members in reference to the wages question, and it was found that 92 per cent. of the employers were in favour of enforcing the proposed 5 per cent. reduction in wages. The number of operatives directly affected is considerably over 150,000. The employers would appear to be united in insistence upon the reduction. They point out that in the good times they conceded, without dispute, several advances, and now the trade is suffering from depression—more severe than it has known for a generation—the operatives should bear some proportion of the loss. The card-room workers' executive, who represent by far the larger proportion of the *employés* affected, and include all the women, have been quick to reply, that they consider the demand hasty and uncalled for, and the card-room workers of the Oldham district, about 17,000 in number, and more than a third of the whole body of operatives following this employment, have unanimously decided to resist the proposed reduction. It is probable that the whole of the 43,000 organised card-room operatives will follow suit. The spinners, whose organisation numbers over 20,000 members, are expected to be almost equally united, and the minor trade unions are expected to follow on the same lines. On the other hand, the employers are strengthened in their insistence upon reduction by the fact that, at the present time, the stocks of goods are far in excess of the demand, and limitation of output would be helpful in restoring the markets to a healthy condition. The official declaration of the ballot of all branches of the trades unions had not been given at the time of going to press, but it will be known today, and the expectation is that it will be against acceptance of the reduction. It would, however, be a mistake to assume that the adverse vote contemplated would necessarily mean a lock-out. Neither side wants to go to extremity. The operatives do not want to lose their accumulated funds, and the employers, though a stoppage would temporarily relieve the situation by clearing stocks, do not like huge dislocations of trade, and the opportunity which the suspension of output gives to foreign competitors. Surely the time has arrived to prevent these recurrent disputes—inevitable under the Brooklands Agreement—by entering into an agreement for the automatic adjustment of wages according to the state of the market. In the last nine years the masters have been offering to submit the periodical adjustment of wages to arbitration, or, in the alternative, to introduce a sliding scale by which wages would rise and fall automatically with trade. Mr. C. W. Maccara is the author of a conciliation scheme which he submitted to a committee of the Employers' Federation in 1899, which proposed to supplant the Brooklands Agreement with a system of arbitration pure and simple. Then the alternative proposal of a Conciliation Board and a sliding scale was elaborated in a document submitted to the representatives of the men, but they decided that the scheme would not work equitably. It was apparently agreed that the principle of automatic adjustment was desirable, and that 5 per cent. was a reasonable return to allow for capital, but the negotiators could not agree as to what is 5 per cent. The employers were, and no doubt are, willing to submit this secondary matter to the decision of independent experts, with an umpire, but to this the operatives' officials would not agree. Thus, as a correspondent of *The Times* puts it, a most promising scheme broke down upon a difference of opinion as to whether a farthing per lb., or ·363d. per lb. is the equivalent of 5 per cent. upon the capital invested in cotton mills!

The Patents Act.—This Act, the Patents and Designs Act, became operative on August 28th. Its principal clause runs as follows:—"At any time, not less than one year after the passing of this Act, any person may apply to the Comptroller for the revocation of the patent, on the ground that the patented article or process is manufactured or carried on exclusively or mainly outside the United Kingdom." In future, foreign manufacturers, if they wish their patents to remain valid in Great Britain, will have to make the goods they sell within the United Kingdom. Otherwise their patents may be copied or infringed at will. Germany and the United States are particularly hit by the new enactment, and they are meeting the altered conditions by (1) building factories of their own in England; (2) acquiring premises already built for the purpose of carrying on their business: (3) arranging with British manufacturers to lay down plant and co-operate in the production of the special articles which are the subject of the patent. Already some thirty foreign firms—many of them conducting operations on a large scale—have begun, or are about to begin operations in this country, most of them choosing the North of England as the scene of their operations. It is said that as a rule the foreign manufacturer is providing a factory many times larger than is really necessary for the construction of his patented article, his explanation being that he cannot run works in England on patents alone, and he intends therefore to manufacture in this country goods that have hitherto been imported ready-made. So far as can be seen at present the Act must profit British labour. It is said in some quarters that these manufactures, at any rate the German ones, will be worked by foreign staffs, but this is not the case at present with Messrs. Meister, Lucius, and Brünning (Limited) of Germany, a company with a capital of £11,000,000, which has just erected a new chemical factory at Ellesmere Port. Here all the workers employed are English, with the exception of a few German overseers. The working of the Act will be watched with keen and anxious attention, for British manufacturers are beginning to

realise that foreign competition is about to invade their own particular territory, and that there will be a fair but strenuous fight on British soil for British custom. That is not a prospect that can be viewed altogether without anxiety when the perfection of German organisation is remembered. The German things to be manufactured in England will be mostly aniline dyes, pottery, plant for gas making, rifles, plated goods, electrical contrivances, furnaces, sanitary appliances, the American, typewriters, safety razors, phonograph records, shoes, telephones, and wire roofing.

Depression in Trade.—Reference was made in these Notes a fortnight ago to the somewhat alarming statements appearing in the Press as to the prevailing depression in trade, and it was suggested that there was a good deal of exaggeration in them. An examination of the particulars of our exports of textile machinery for July supports this view in so far as this particular branch of industry is concerned. Here are the figures for the month of July for the last three years:—

1906.	1907.	1908.
£	£	£
584,699	776,375	761,811

It will be seen that there was a slight falling off this year as compared with the exports in July 1907, but comparing 1908 with 1906—which was a year of great activity—the figures for 1908 show a very large increase. Taking July of last year and the same month of this, it will be found that the textile machinery shipped to Russia increased from £36,814 to £62,654; that for Japan increased from £45,347 to £78,179; that to "Other Countries" from £29,663 to £31,415. The principal decreases were in the exports to Germany, France, North and South America, and India. If the figures for the expired seven months of the year are taken and compared with those of last year, they still show a great increase, the total being £5,187,850, as against £4,570,094 in 1901, and £3,736,830 in 1906.

The English Silk Industry.—This industry has for some time past been depressed owing partly to reduced demand in the home trade, and also to larger offerings of foreign goods due to the stagnation of the American market. This year's consumption of raw material is likely to show considerable decrease, and there is also a decline in the use by English manufacturers of foreign throwns, most of which come from France, although a considerable quantity credited to Holland in the Board of Trade returns is of Swiss production. Leek firms are doing better than producers elsewhere in sewing silks, braids, tailors' twists, embroidery filoselles, and other articles of the same class. An extensive use of artificial silk in England is barred by its high specific gravity, and its unsuitability for exposure to the weather, but the silkworm remains unbeaten as a producer of commercial silks, although the artificial silk can no longer be merely regarded as a scientific novelty. In some branches of the silk-throwing trade mercerised cotton is a much more dangerous competitor, and there is the competition of Italian spun silk yarns, in bundles and in warps, in the Bombay and other markets. The presence of increasing quantities of Japanese silks continues to be felt. The cloth is now used largely by European printers, and the gum twill trade with Paris has been largely secured by Japan.

NOTES ON BOOKS.

George Baxter (Colour Printer): his Life and Work; a Manual for Collectors. By C. T. Courtney Lewis. London: Sampson, Low, Marston and Co. 8vo.

The colour prints of George Baxter, which for many years were widely circulated, are now being sought after by collectors, and it has been thought well to produce a manual for their guidance. The author says that there is still much to be learnt as to the prints published by Baxter, the dates of his publications, and the discrimination of those signed and unsigned.

Mr. Lewis writes:—"For those fond of research there is a considerable field open. Our present scanty knowledge might be much increased by a thorough inspection of the newspapers and other journals of Baxter's day since their sources might furnish much information that is still wanting. Indeed, there are several prints he advertised his intention to publish, of which no specimen has been found yet, so that it is uncertain if they were actually produced."

Baxter was the second son of John Baxter, printer and publisher, and was born at Lewes, on July 31st, 1804. He early took to wood engraving and lithography, and worked for his father. In 1827, he was engaged on the engravings to Horsfield's "History of Lewes," and to Baker's "Select Sketches in Brighton." It has been asserted that he produced a small print in colours in this same year, but his earliest colour work, known to the author, is a print of "Butterflies" (1829), and this is not an oil-colour print. The earliest example of his use of oil-colour was published in 1834, and from that year his special work must be dated. In the Appendix is reprinted the correspondence in 1856 between Miss Savage and G. Baxter which appeared in the *Daily News*. The former claimed for her father the priority in the improvement of colour printing, and Baxter, in his reply, describes himself as "Inventor and patentee of oil colour picture painting." The Society of Arts presented, in 1825, the large silver medal and fifteen guineas to William Savage "for his improvements in Block Printing in imitation of Coloured Drawings." The description of his work was published in the 43rd volume of the Society's Transactions. Mr. Lewis gives a full descriptive account of Baxter's prints from

1829, with their sizes and the probable purchaseable value of each print if in perfect condition. Some of the prints are reproduced in black and white, and the frontispiece consists of "The Coronation of Queen Victoria," which is described as Baxter's masterpiece. There is a useful alphabetical index to all the prints.

In the Appendix there is a report of the proceedings before the Judicial Committee of the Privy Council in 1849 on Baxter's application for an extension of his patent. Two specimens were handed to the Committee, and Lord Brougham said he would purchase them. The petitioner was desirous of presenting them, but Lord Brougham said "I am reminded by my noble friend [Lord Langdale] that if I don't pay I am accepting a present in an official capacity. I should therefore be liable to impeachment." The patent was extended for a period of five years "without any limitation whatever."

University of London. The Libraries of London: A Guide to Students, by Reginald Arthur Rye. London, 8vo.

This, a useful account of the numerous libraries in London, with statistics of the number of volumes in each, and the particular character of the different collections. There is also a notice of Special Libraries arranged in an alphabet of subjects from "Accountancy" to "Zoology." The third division consists of an account of Libraries connected with Educational Institutions.

In the introduction there are some statistics of the comparative numbers of books in the different libraries, and the population of London. From these it appears that London only provides a little over one volume per head, while Berlin possesses over two volumes per head and Dresden three volumes, but such statistics are somewhat misleading.

This book is published and sold by the University of London.

The Students' English Dictionary. By John Ogilvie, LL D. Edited by Charles Annandale, LL.D., with explanatory illustrations in the text. Blackie and Son. Small 4to.

This well-known Dictionary has been completely recast so as to form a new work. It is a full and convenient book of reference issued at a low price.

Industrial Conference held at Surat, December, 1907. Full text of Papers. Madras.

This volume contains all the papers (eighteen in number) read at the third Indian Industrial Conference held at Surat. The subjects dealt with were very varied in their scope. They were:—Method of an Industrial Survey; Coal Mining Industry of India; Arts and Industries of Travancore; Agricultural Development in Bombay; Lift Irrigation; Co-operative Credit Societies in the Bombay Presidency; Commercial Education; Technical Education for the Workman; Desirability of Agricultural Exhibitions in the Bombay Presidency; Cultivation of Cotton in India, the Central Provinces and Berar; the Handloom of Ahmednagar; the Salem Weaving Factory; and Industrial Banks.

Bengal: Past and Present. Vol. ii., No. 2. April, 1908.

This quarterly publication of the Calcutta Historical Society contains much interesting matter, and is fully illustrated. Amongst the contents are articles on "Bishop Wilson and the Second Earl of Clare. A Chapter in the Secret History of Steam Navigation," by the editor, Rev. Walter K. Firminger, D.D.; "Old St. James's," a former Calcutta church which was built upon an insecure foundation, and collapsed in 1858; "Some Transactions of the Calcutta Historical Society;" "Leaves from the Editor's Note Book;" and "A Review, and some Remarks," by Wilmot Corfield. Mr. Corfield's contribution, which continues a previous notice of Mr. H. E. A. Cotton's "Calcutta: Old and New," refers to and quotes from the address on "Lord Clive and his Part in the Foundation of the Indian Empire," delivered by Sir Steuart Colvin Bayley in November, 1907. The Society and its Journal deserve to be better known in this country. The address of the Hon. Secretary, 5, Diamond Harbour-road, Kidderpore, Calcutta.

OBITUARY.

Earl of Rosse, K.P., D.C.L., LL.D., F.R.S.—Lawrence Parsons, fourth Earl of Rosse, who died on the 29th August at Birr Castle, King's County, Ireland, was elected a Member of the Society of Arts in 1891. He was born on November 17, 1840, and succeeded his father in 1867. He was elected an Irish Representative Peer in the following year, and in 1890 he was created a Knight of St. Patrick. He was elected a Fellow of the Royal Society in 1867, and in 1873 he delivered the Bakerian Lecture on the "Radiation of Heat from the Moon" before the Royal Society. He carried on his father's researches at the Birr Castle Observatory, and in 1868 his "Account of the Observations on the Great Nebula in Orion, made with the 3 feet and 6 feet telescopes, between 1848 and 1867," was published in the Philosophical Transactions. His scientific papers were mostly published in the Phil. Trans. and Proceedings of the Royal Society.

Lord Rosse had been since 1885 Chancellor of Dublin University (an office previously held by his father, William third Earl of Rosse, who was President of the Royal Society from 1849 to 1854). He served as President of the Royal Dublin Society from 1887 to 1892, and as President of the Royal Irish Academy from 1895 to 1900.

Correction.—Page 902, col. 2, line 19, *for* 10 *read* 20 gallons.

Journal of the Royal Society of Arts

No. 2,912. VOL. LVI.

FRIDAY, SEPTEMBER 11, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

STOCK PRIZE.

The Council of the Royal Society of Arts offered under the terms of the Stock Trust, a Gold Medal, or a Prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the annual competition held during the present year.

The Prize was offered for the best original designs for an architectural decoration, to be carried out in painting, stucco, carving, mosaic, or any other process suitable for the side of a room or a hall, a ceiling, the apse or side of the chancel of a church, or part of the interior of a building.

Acting on the recommendation of the Board of Education, the Council of the Society have awarded the Prize to Frederick Sydney Smith, School of Art, West Bromwich, for a Design for the Decoration of a Church Interior.

The designs were submitted, with other school work, in the usual manner, to the Board of Education, South Kensington, in April, 1908.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE THEORY AND PRACTICE OF CLOCKMAKING.*

By Sir Henry Hardinge Cunynghame, K.C.B.

PART I.

The mysterious character of time has led philosophers to wonder how far its existence is real, or at least how far it is, in reality, as we understand it.

These views culminated in the opinion of Kant, who treated time as a mere form or condition of human receptivity, so that as apart from sentient beings time had no existence at all.

I have not time here to follow the interesting train of reasoning by which the great thinker sought to show the subjective character of time, but I may briefly say that he considered his conclusions established by the fact that time of itself cannot be conceived apart from other things, and that it has no material objectivity. ("Critique of Pure Reason," Part I., Sec. 2).

Those whose method of thinking leads them away from abstract speculation will no doubt deride these views. For them matter is matter and time is time, and they wish to know nothing more about them.

And for the practical clockmaker this view must be sufficient. To him time is a reality, and his art is directed to find means for its measurement.

To this end we must endeavour to determine a standard of measurement for time. A number at once present themselves. The speed of thought might be a standard, but that it is so uncertain. We might watch chemical changes, or the growth of animals or plants. But, of all the changes which go on around us, and on which we might base our standard of time, none appears more suitable than the motion of matter through space. And of all the bodies in motion, and modes of motion, none appears more suitable than the rotation of the earth upon its axis. From historical and astronomical considerations, which it would be out of place to consider here, it appears probable that the velocity of spin of the earth upon its axis is uniform. If it changes, and some think that its velocity does change, then such variation in its rate of speed is exceedingly small, and for our purposes inappreciable. So smooth and steady is this spin in space that we can detect no irregularity, and it has always been selected as the standard of measurement of time.

Since the spin of the earth upon its axis is

* The Course consisted of Six Lectures, delivered Jan. 20, 27; Feb. 3, 10, 17, 24. In re-arranging the material for publication, the Lecturer has preferred to divide it into Four Parts.

regular, it follows that the stars ought to pass the meridian uniformly, and in regular order. And this would be the case if the earth's axis were always parallel to itself in space. But this is not so. Just as a top, when it spins, not only turns, but also "wobbles" round on its point, so the earth's axis slowly revolves in a cone making a complete revolution in 40,000 years. Whence it happens, that each year the place of the stars slowly varies.

For the purpose of clockmaking, however, we may treat the sidereal revolution of the stars as constant.

It has been customary from the earliest ages, among the Chaldeans and the Egyptians, to treat the complete days as divided into 24 hours, divided into 3 watches of 8 hours each, commencing at midnight.

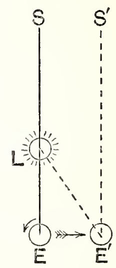
The Greeks adopted a different system. They divided the day, from sunrise to sunset, into 12 hours; and likewise the night. Whence it followed that the length of the Greek hour and day constantly varied; whereas the Egyptian is uniform.

The division into 60 minutes and 60 seconds is derived from the ancient nations—especially the Greeks. For it must be remembered that our present decimal notation was quite unknown to the Greeks.

Even in such a work as the great syntaxis of Ptolemy, all the calculations are made in sixtieth parts, not in decimals. And hence, minutes and seconds were also used in the computation of time. When the decimal system, first adumbrated by Archimedes, developed by the Arabians, and then reintroduced into Europe, came into vogue, the measurement of time was left unchanged. And we inherit from the Greeks our minutes and seconds of time.

The sidereal day is divided into 24 hours, each of 60 minutes, and each minute contains 60 seconds. Such a system would, however, be inconvenient for popular use. In that case the hours of the day would depend upon the meridian passage of the stars, not upon the meridian passage of the sun. For, of course, as the earth while it rotates on its axis, turns round the sun, S, in the same direction, while it makes 366 rotations on its axis as compared with the fixed stars, it only makes 365 as compared with the sun. If, therefore, the sun and a star are in a line, when viewed from the earth, then when the earth has made one revolution as compared with the stars, it will have made more than a rotation as compared with the sun. This may be seen from the diagram. The lines to the fixed star, E S, E′ S′ may be treated as parallel, owing to the immense distance of the star, which makes the want of parallelism between E S and E′ S′ incapable of being measured even by delicate telescopes. Whence, then, it is clear that the sidereal day, or the earth's time of turning once on its axis with regard to the star is shorter than its time of turning on its axis with regard to the sun, by the angle E L E′, where E E′ is the amount travelled by the earth in a day. And it is also clear that the angle E S E′ is $\frac{1}{365}$ part of 360°, whence then, the lag of the sun amongst the fixed stars will be $\frac{24}{365}$ hours daily, or nearly 3 min. 56 sec. Moreover, since the path of the sun round the earth is an ellipse, with the sun not in the centre but in one of the foci, it will follow that sun time constantly varies, the

FIG 1.



day of 24 hours being rather shorter in winter than in summer. In order to get rid of this inconvenience it is customary to take as our measure of time an imaginary "mean" sun, which is supposed to go round the earth in 24 hours at a uniform speed. It takes 365 days 6 hours 9 minutes 9·6 seconds of civil time for the earth to make the complete circuit of its path. Hence, then, the sidereal day, or time of revolution of a star round the earth to the same meridian, that is to say 24 hours of sidereal time, is 23 hours 56 minutes 49 seconds of civil time.

From this it of course follows that the sidereal hour, minute and second are shorter than the civil hour, minute and second, so that a civil clock does not keep the same time as a sidereal clock, of which the pendulum is shorter.

On April 15th the sidereal and civil time agree, thence onward the sidereal day is shorter than the civil day. True sun-time, that is the time shown by the apparent sun, will, of course, be different again from civil time. But apparent sun time is not used. All

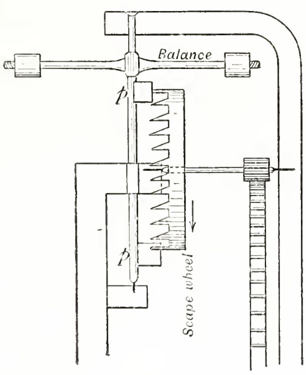
that is done is to note the civil mean time on which the apparent sun is on the meridian. This is 12 o'clock mean time on April 15th. After that, the sun's shadow on the dial (that is, apparent time) is in advance of mean time till again they become the same. Tables are given in nautical almanacks for correcting mean time into sidereal time, and vice versâ, and also the variation of time is given, that is to say, the civil time for every day of the year while the apparent sun is on the meridian.

I do not propose to go into the history of clocks, because it has been made the subject of many books, among which I may mention the fine work of F. J. Britten on "Old Clocks and Watches and their Makers." (London: B. T. Batsford, 1904.)

It does not seem certain that anything of the nature of a modern clock existed in Europe until the early part of the fourteenth century. From that time onwards for about 300 years clocks were constructed in various churches and abbeys. They were all upon one system. It is difficult to divine who was the inventor of these clocks. In England a monk of Glastonbury, Peter Lightfoot, seems to have been our earliest clockmaker, and a clock made by him for the Abbey still exists. At the dissolution of the monasteries the clock and works were transferred to Wells Cathedral, where the dial now remains. The inside was renovated in 1835, but the works, which are now about 580 years old, are still going at the Museum in South Kensington.

The working of this curious old clock will be understood from the adjoining diagram. A

FIG. 2.



crown-wheel, which so called from the shape of its teeth, is mounted on a shaft, in bearings, and caused to revolve by means of a weight or spring. A shaft carries two leaves or pallets, *p p*. These engage the teeth of the crown wheel in such a way that, as it revolves, the pallets are alternately pushed to and fro, causing a reciprocating motion to be given to the shaft. In order to slow down this reciprocation, a balance is fastened to it, with weights at the ends. It is clear that at each reciprocation two forces meet and oppose one another, viz., that produced by the push of the point of the teeth against the pallet, and that produced by the inertia of the staff, which, swinging the other way, presses the pallet against the tooth. The former at last overcome the latter, because it has the constant pull of gravity for its cause, while the other has only the inertia of the balls which is gradually exhausted. As soon as that takes place, the balls swing the other way, the crown wheel advances a step, and the movement is repeated.

This movement is called an escapement. The principle of it is to let the teeth of the crown wheel "escape" at intervals from the clutch of the pallet. If the wheel has 30 teeth and the weights swing once in a second, the wheel will rotate once in a minute, and then, by means of cogwheels or some equivalent device, its motion can be communicated to the hands of a clock, or made to release other trains of wheels, which cause figures to move and perform the motions of ringing bells or riding round, which were so popular in olden days, and the taste for which, in our more prosaic days, has now passed away.

It will of course be seen that this escapement was scientifically imperfect. If the clock became stiff or clogged the driving weight was less effective to move it, hence the impulse diminished. The resistance, however, would similarly diminish. Thus it by no means happened that the amplitude of swing was always the same. It will be shewn hereafter that the time of vibration of this escapement varies with the arc of swing of the balance. If, therefore, the amplitude of swing is changed the time will change also.

Galileo was the first to observe that the swings of a pendulum are performed in very nearly equal time, whatever be the arc of swing. He used this discovery to make a counting machine by which doctors should measure the rate of pulse-beat of their patients, but he never utilised it further or applied it to clocks. His son, Vincenzio, is believed to have done so, though it is claimed that Huygens, a Dutch mathematician, was the first inventor.

In any case, to Huygens is due the credit of investigating the mathematical conditions of the swing of a pendulum, a task which Galileo,

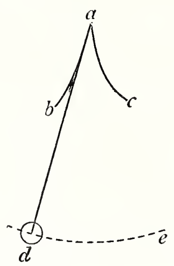
though greatly superior in genius to Huygens, never accomplished.

The theory of the pendulum will be dealt with hereafter.

The practical improvements proposed by Huygens are as follows :—

First having discovered that the true isochronism of a pendulum depended upon its having a cycloidal arc, and that a common pendulum, though nearly isochronous, is not truly so, for very different arcs of swing, he

Fig. 3.



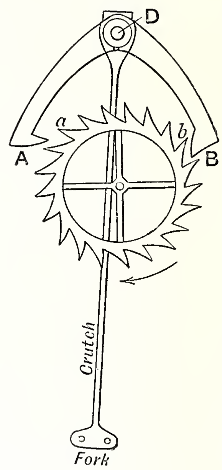
proposed to make the arc cycloidal by making the pendulum of a flexible cord, swinging between two arcs *a b*, *a c*, by which means the path *d e* was made cycloidal, but the friction of the cord introduced more error than it cured. His discovery caused the clocks which existed in his day to be converted into pendulum clocks. This was really very easy, for it was only necessary to remove the balance arm and to replace it by a pendulum, and you had a clock which would go far better than with the verge or balance. Most old seventeenth century clocks will be found on examination to have been altered to pendulum clocks.

There were, however, considerable disadvantages still left with the crown wheel escapement, because each release demanded that the pendulum should oscillate through a considerable angle, and thus the swing of the bob was very wide. This introduced error; for, as we shall see, the law that makes the pendulum isochronous is only true when the arc of swing is small. To remedy this, Hooke invented the anchor escapement, which enables a release to be effected with but a small swing of the pendulum; this is in use in grandfather clocks in our own days.

The adjoining figure of the anchor escapement, or better still, a careful examination of the works of a grandfather's clock, will show the action.

When the anchor is in the position shown in the diagram, the tooth *b* presses upon the pallet B and tends to drive it away, thus forcing the pendulum rod, which is fastened to the axle D of the anchor, to move to the right. As soon, however, as the tooth D is clear of *b* this pushing action terminates, and the pendulum, by virtue of its weight, is free to swing back again from right to left. The wheel, however, can not turn round, for the pallet A stops the teeth from moving. When, however, the pendulum comes to the left hand, the pressure of the teeth on the pallet A urges the anchor and pendulum round from left to right, and so the action goes on. It is to be observed that as soon as the tooth quits the pallet B a tooth slips into pallet A, with the ticking sound that is well known. As, however, the pendulum has inertia, it does

Fig. 4.



not stop at once but goes onward on its path, causing the teeth to be pushed up backwards along B. This causes a recoil. If any grandfather's clock be noticed, this recoil may be observed. We shall later return to this question and examine the consequences of the recoil. It is enough here to say that it produces inaccuracies in the time keeping. To avoid them, the dead beat escapement of Graham was invented, the only difference between it and the anchor being the changed form given to the pallets. This beautiful escapement has merits which have always excited the admiration of all who have studied it. Curiously enough, as I think I shall be able to show, its chief point of merit was overlooked by Sir George Airy in his excellent analysis of escapements. This escapement in practice is almost perfect for astronomical clocks. I shall recur later to the mode of designing it. The great advantage of the

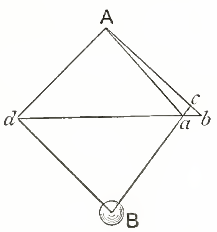
anchor and dead-beat escapements was that they enabled the arc of vibration of the pendulum to be small.

As I shall subsequently show, it is not true that the common pendulum is isochronous, no matter what the extent of the swing. The difference of time of swing is not great between a small one and one that is only slightly longer. But when once the arc depasses three or four degrees, a very small difference of swing produces a perceptible difference of time of swing, and hence the time keeping would depend on exact uniformity of arc of swing, a condition very difficult to attain in practice, as will subsequently be shown.

The anchor escapement was not the only invention of that great mechanician Dr. Hook. He likewise invented the first form of the compensation pendulum. Knowing that an iron seconds pendulum rod expanded about $\frac{1}{4000}$ of an inch for each degree Fahrenheit, and that this expansion produced an error of about $\frac{1}{4}$ second in a day, it was clear that in winter at freezing point a clock would go about 12 seconds a day faster than in summer at a temperature of 80°F. And an ordinary grandfather clock is subject to this error.

Hook designed to keep the bob of the pendulum at a uniform level. He therefore

Fig. 5.

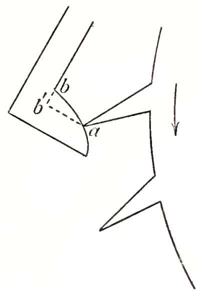


proposed a rhombohedral pendulum with iron sides, but a horizontal copper diagonal, so arranged that on a rise of temperature, the expansion of the copper rod *d a* carried the bob upwards as much as the expansion of the four iron sides let it downwards, so that the distance A B remained constant.

This made, of course, a very clumsy pendulum, for the length of the rod was considerable, and the thing looked like a kite.

The next great improvement upon clock escapements was the invention by Graham of the dead-beat escapement. This consisted in cutting away a portion of the anchor, as shewn in the sketch, so that the tooth, instead of riding up from *a* to *b*, and thus causing a recoil, rides along on the level to *b′*, keeping perfectly steady the while, so that the seconds hand attached to the escape wheel remains motionless or "dead." The advantage of this movement was that the pendulum at each side of the swing is not nnder the influence of any force, but only subject to the friction retardation as the tooth runs from *a* to *b′*. At

Fig. 6.



first sight it might appear that this friction was a drawback. It will, however, when we come to deal with escapements, be shown to be an advantage, and one of the circumstances which conduce to the excellence of Graham's escapement.

Another invention of Graham, which has been widely used, is the compensation mercury pendulum. A rod of iron or steel, 100 cm. long, expands about ·0012 cm. for each 1° C. increase of temperature. This can only be compensated by making the centre of gravity of the bob expand upwards by a similar amount. Now the coefficient of expansion of mercury, when enclosed in a glass vessel, is found to be about ·00008. Hence a jar of mercury, about 15 cm. high, will have its centre of gravity raised by about ·0012 cm. for each 1° C. of increase of temperature, so that its expansion upwards will compensate the expansion downwards of the steel rod.

A more exact computation of the mercury pendulum will be given further on.

Harrison, the famous clockmaker, to whose exertions we are indebted for the earliest chronometer, invented the gridiron pendulum. The principle of this pendulum is to arrange a gridiron of seven or nine bars alternately of brass and iron so that the upward expansion of the brass bars compensates the downward expansion of the iron ones. The method of compensating the pendulum will also be given.

To Huygens we owe the endless cord and weight for winding, by which means the operation of winding does not arrest the impulse or driving force of the weight on the clock. The same effect is produced by Harri-

son's maintaining spring, or by the bolt and shutter.

Meanwhile a totally different escapement had been proposed, and was in use for watches. Tompion was the originator of the idea of a detached escapement, by which is meant an escapement which gives an impulse to the pendulum through a small arc in the centre of its swing, and then is detached, leaving the pendulum absolutely free. The freedom of a pendulum at the ends of its swing is highly to be desired. For it must be remembered that by reason of the isochronism of the pendulum, a bob projected from its lowest point of rest will rise to a height and then return, and its time of excursion and journey back is entirely independent of the force of the push out. But this independence is only true if the pendulum is quite detached and free. Whence then it follows that an escapement which only engaged the pendulum at the middle of the swing would be an advantage.

Berthoud, in France, contrived various forms of detached escapements for watches, but I am not aware that one was designed for a clock earlier than a chronometer escapement for a clock mentioned in Rees' "Encyclopædia," which is said to be anonymous. This makes a very effective one.

Sir George Airy contrived an escapement much on the same plan, which has been going very successfully at Greenwich for many years.

Meantime, however, another plan was suggested both for watches and clocks. Inasmuch as the friction of a train varies very much, it was suggested to put a small mainspring close to the escapement, and then keep winding it up repeatedly to a fixed amount at frequent intervals, using for this purpose a large mainspring and train. This was called a remontoir. The effect was excellent and answers well. I will describe it more in detail in a subsequent lecture.

Another plan was also suggested and carried into practice on the same principle as the remontoir, namely, to use a train of wheels to wind up a weight and let it fall at suitable intervals upon the pendulum rod. By this means the driving impulse given to the pendulum would be always uniform. This plan, called the gravity escapement, was first suggested in the eighteenth century by Cummings. A practical form of it was devised by Mudge, a famous watchmaker, and one on his system is still going at Dent's shop in Cockspur-street. Mudge's escapement had, however, several faults which were remedied in Bloxham's escapement.

This, however, was said not to be a success, so Becket Denison, who afterwards became Lord Grimthorpe, made some alterations in the design, and added a fly to steady it. This escapement has usually gone by the name of Denison's escapement, but the merit of its invention unquestionably belongs to Bloxham, who published several profound and excellent mathematical investigations on the pendulum, and who also invented the dipleidoscope. I shall recur to this question again when I describe the gravity escapement. The gravity escapement is not detached.

I may add that about two years I made a detached gravity escapement that seems to present some useful features, and which lends itself very well to use for electrical clocks. This also I will describe later on.

To trace the progress of invention in electric clocks, which, in my opinion are the clocks of the future, would be an almost endless task. Briefly it may be said that electric clocks are divided into three types.

1. Where the pendulum is actuated by the intermittent attraction of an electro-magnet.

2. Where the pendulum is driven by a mechanical escapement wound up at regular intervals by electricity.

3. Where the escapement is actuated electro-magnetically.

In all these cases the current can be employed to drive a number of dials.

Then again there is a group of clocks electrically synchronised ;—

1. By intermittent action of electro-magnets on the pendulum.

2. By the action of electrically driven cams upon the hands.

An enormous number of different varieties of the above have been invented, but not many of them have been made practically successful. For there is no branch of mechanics in which it is so difficult to turn theory into successful practice.

Appendix to Part I.

Some observations upon units of measurement and gauges, and a few useful data.

In the following pages I have employed, where possible, metric measurement, because it is far the simplest for clockmakers. I have written the letters with a dash over them. Thus $\bar{c}$ represents centimetres, $\bar{m}$ metres, $\overline{mm}$ millimetres, $\bar{g}$ grammes, $\bar{k}$ kilogrammes, and so on. For square measure

the dashes are doubled thus: $6\,\overline{\overline{c}}$ means 6 square centimetres, and $6\,\overline{\overline{\overline{c}}}$ means 6 cubic centimetres.

The unit of length of the metric system is the metre divided into 100 centimetres and 1,000 millimetres. The metre was originally intended to be a ten millionth part of a meridional arc of a circle drawn from the North Pole through Paris to the equator. But to secure an invariable standard, the length is taken as a bar made of platinum and iridium, and preserved in the International Bureau of weights and measures near Paris.

1 metre = 39·370113 inches.
1 centimetre = 3·9370113 inches.
1 inch = 2·540005 centimetres.
1 foot = ·304800 metres.

The metric unit of mass is the gram. It is in reality an arbitrary standard made of metal, but is intended to be the mass of 1 cubic centimetre of pure water.

1 kilogram = 1,000 grams. = 2·20462 English pounds avoirdupois.
1 lb. (avoirdupois) = 453·592427 grams.
1 oz. avoirdupois = 28·3495 grains.
1 gram = 15·4323564 grains.
1 grain = ·0647989 grams.

The following are the three sets of weights which, to our confusion, are still used in Great Britain. The grain weight is common to and the same in all three systems.

Avoirdupois. (General use.)
1 lb. = 16 oz. = 128 drams = 7000 grains.
1 oz. = 8 drams = 437·5 grains.
1 dram = 27·34375 grains.

Troy. (Jewellers.) (The lb. is not used.)
1 oz. = 20 pennyweights = 480 grains.
1 pennyweight = 24 grains.

Apothecaries' weights. (The lb. is not used. When 1 lb. is wanted apothecaries use the avoirdupois.)
1 oz. = 8 drams = 24 scruples = 480 grains.
1 dram = 3 scruples = 60 grains.
1 scruple = 20 grains.

Liquid Measure.

1 gallon = 4 quarts = 8 pints = 160 fluid ounces.
1 gallon of water weighs 10·0221 lbs. (avoirdupois) = 70154·7 grains.

1 fluid oz. of water, therefore, weighs just about 1 oz. avoirdupois = 437·5 grains. The ordinary imperial gallon and pint measures are much used by apothecaries, though they do not correspond with their own ounce weight, which weighs 480 grains. For smaller quantities of fluids apothecaries use 1 oz. = 8 drachms = 480 minims or drops, so that a fluid drachm of water weighs 1 dram, and a drop of water weighs 1 grain. 1 cubic inch of water weighs 252·893 grains = ·036127 lbs. (avoirdupois). 1 cubic foot of water weighs 62·4283 lbs. (avoirdupois).

Specific gravities of substances are their densities as compared with water. According to the well-known law of Archimedes, if W be the weight of a substance, and W′ its weight in water, then its specific gravity is to that of water, which is taken at unity, as $\frac{W}{W - W'}$.

Temperatures are measured in England by Fahrenheit's scale, by which freezing water is 32°, boiling water 212°, and the rest intermediate. The Centigrade system has zero for the freezing point, and 100° for the boiling point of water. Réaumur has 0° for freezing point, but 80° for boiling point.

1 Centigrade degree = 1·8° Fahrenheit.
1 Fahrenheit degree = $\frac{5}{9}$ Centigrade degree.

Absolute cold, below which the molecular motion of heat does not exist, is − 256° C. The absolute temperature of freezing water is thus 256° (absolute). Expansion co-efficients are the proportions by which heat expands bodies. They are usually linear. Volumetric ones are three times the linear for the following reason. Let p be the linear co-efficient of a substance. Then by the heat or other cause of expansion a *length* P becomes $P + Pp$. Whence the volume P^3 becomes $(P + Pp)^3 = P^3(1 + p)^3 = P^3(1 + 3p + \ldots\ldots)$ (neglecting the terms beyond the second). Thus, the new volume, $= P^3 + 3P^3p$, which shows us that the volumetric expansion co-efficient is three times the linear expansion co-efficient.

A few of the most important expansion co-efficients are as follow. They are only approximate, for different specimens of substances have different co-efficients.

	Density.	Coefficient per 1° C. of linear expansion.
Steel	7·816	·00001152
Iron	7·207	·00001127
Copper	8·879	·00001712
Brass	(variable)	.0000189
Zinc	6·862	·0000297
Lead	11·445	·0000281
Deal	·3 to ·9	·00000432
Glass (crown)	2·488	·0000082
Mercury	13·596	·0000606
Silver	10·474	·00001910
Platinum	21·837	·0000084
Gold	19·358	·0000146
Invar	?	·00000038 (Very variable.)
Aluminium	2·615	·00001087
Air	·0012940 (At $76\,\overline{c}$ barometric pressure and 0 C. temp.	·0004070

$$\text{The value of } \pi = 3{\cdot}1415926$$
$$\log \pi = {\cdot}4971499$$
$$\frac{1}{\pi} = {\cdot}3183099$$
$$\log \frac{1}{\pi} = \bar{1}{\cdot}5028501$$
$$\pi^2 = 9{\cdot}8696044$$
$$\log \pi^2 = {\cdot}9942997$$

Mechanical value of heat = 426·900 kilogram-metres per kilogram-calorie.

In the metric system force is estimated in dynes. A dyne is that force which, acting on a gram for a second, produces a velocity of 1 centimetre per second. 1 dyne is the force by which 1·0197 milli-grammes of matter is attracted to the earth at Paris. According to English measures, a poundal is that force which, applied to a mass of 1 lb., will give it a velocity of 1 foot per second.

Seeing then that the force of gravitation at London, will, by acting for one second on a mass of matter, give it a velocity of 32·1717 feet per second, it follows that 1 poundal = ·0310832 pounds weight = 13825·5 dynes.

Energy or work is measured according to the metric system in ergs. 1 erg is the work necessary to drag anything against a force of 1 dyne through 1 centimetre. Whence 1 erg = ·00101979 gram—weight—centimetres of energy.

Time is either solar or sidereal.

The sun appears to revolve round the earth once in 365 d. 6 h. 9 m. 9·6 s. of mean solar time, or 366 d. 6 h. 9 m. 9·6 s. of sidereal time.

24 hours of sidereal time are equal to 23 h. 56 m. 4·09 sec. of civic time.

The ratio of the solar to the sidereal day is 1·00273791, and 1 day = ·99726957 mean solar days.

The acceleration of the stars in a solar day = 236·55535 secs. sidereal time = 235·90945 secs. solar time.

EDUCATION UNDER THE LONDON COUNTY COUNCIL.*

I. The London Council became the Local Education Authority for the Administrative County of London on May 1st, 1904. The Council not only succeeded to the powers and duties of the London School Board, but is also required to "maintain and keep efficient all public elementary schools within the area which are necessary." Further the Council, which had previously, under the Technical Instauction Acts, been responsible for the supply of technical education, was entrusted by the Act of 1903 with powers relating to all branches of higher education, and was commissioned "to supply or aid the supply of education other than elementary, and to promote the general co-ordination of all forms of education."

All matters relating to the exercise of their powers under the Education Acts, except the power of raising a rate or borrowing money, stand referred by statute to the Education Committee of the Council, and the Council before exercising such powers, unless in their opinion the matter is urgent, receive and consider the report of the Education Committee with respect to the matter in question. The Council may delegate to the Education Committee any of their powers under the Education Acts except their power of raising a rate or borrowing money. The Education Committee is composed of fifty members, of whom thirty-eight are members of the Council, and twelve co-opted members (including six women). The powers and duties of the Education Committee are distributed among eleven sub-committees. The Education Committee is assisted by 180 statutory bodies of managers for provided elementary schools, while the statutory bodies of managers of non-provided elementary schools number 367. In the management of its own secondary schools, training colleges, technical institutes, and schools of art, the Education Committee is assisted by advisory or local sub-committees. The Council also appoints representatives to serve upon the governing bodies of all schools and institutions to which it makes grants.

II. Area of the administrative county, 120 square miles; population, 4,795,757. School rolls:—Public elementary, 734,288; provided, 566,086; non-provided, 165,620. Public secondary, 32,010; provided, 3,070; aided, 16,158; non aided, 12,779. Technical, 50,800; provided, 7,700; aided, 38,600; non-aided, 4,500. Ordinary evening schools, 121,208. Training colleges, 1,363.

In these figures neither the University of London, the Imperial College of Technology, nor the schools of the University are included, although the Council aids them all.

The Council spends five and a half millions sterling (round figures) on education, £4,500,000 on elementary, and £1,000,000 on higher. The receipts amount to £1,750,000; the rest of the cost falls on the ratepayer. The education rate is 19d. per pound; a penny rate raises about £185,000.

The administrative staff consists of 1,000 officers, including 41 inspectors and 28 organisers; and there are 20,000 teachers engaged in some 3,000 schools or departments of schools of all kinds.

III. The Council purchases sites, designs and erects its own schools, equips the schools with furniture, desks, books, and apparatus; supplies fuel and light; does its own repairs; engages, pays, trains and affords further training to its own teachers.

IV. *Elementary Schools.*—Education is free in all public elementary schools (provided and non-provided). The enforcement of school attendance employs a large body of officers. With relatively few references to the magistrate the average school attendance is maintained at 88·9 per cent. of the average roll.

The subjects of instruction, in addition to those usually found in public elementary schools, include elementary science, nature study, domestic economy, manual training, physical exercises, swimming, and in certain cases modern languages. A strong endeavour is made by means of conferences and consultative committees to secure in the management of the schools the assistance of the expert views of the 20,000 teachers.

Much attention has been given to medical inspec-

* Abstract of a paper read by R. Blair, M.A., B.Sc., Executive Officer, London County Council, before the Education Section of the British Association, at the Dublin meeting, 1908.

tion, a comprehensive system having been established before the passing of the Education (Administrative Provisions) Act of 1907.

Voluntary funds provide meals for necessitous children.

Some 2,000 of the ablest of the children in the elementary schools annually receive scholarships, including free education at secondary schools; in the majority of cases the scholarship holders are assisted by maintenance grants. There are further scholarship schemes for trade schools and for higher institutions, including the universities. For the weakest, medical inspection. For the physically and mentally defective, special schools, with a roll of 9,000; and for those not under control there are industrial and reformatory schools.

Voluntary associations provide play centres, vacation schools, country holidays, and happy evenings for thousands of London elementary school children.

Physical education, including organised games and medical inspection, have received much attention and are going to receive more. Visits to places of educational interest are a feature of the school work. Some of the elementary schools have themselves organised school journeys. The Council has experimented on open-air schools. A small botanical department supplies to the schools 900,000 plants and other Nature-study specimens per month.

There is an annual requirement of 1,100 elementary teachers. These are in the main obtained by means of the "College List," a procedure understood to be special to London. Some eighty head-teachers are appointed annually, according to a scheme of promotion which begins with consideration of the claims of every eligible assistant. A scheme for further training brings the practising teachers into direct contact with the University.

V. *Secondary Schools and Training Colleges.*—The Council's policy is to provide or assist in providing secondary education, at a moderate fee, for those who are able to avail themselves of it, and to offer the advantages of secondary education, free of charge, to the most promising children from the elementary schools. As previously shown, the secondary schools of London contain 32,010 pupils, 3,070 in the Council's own secondary schools, 16,158 in aided secondary schools, and 12,779 in non-aided secondary schools. These numbers include the students attending the first-grade secondary schools, where the leaving age is approximately nineteen, but they do not include any pupils in attendance at private secondary schools.

The cost of secondary schools, scholarships, the training of teachers, and University education apart from the administrative staff and loan charges, is estimated at £450,000 for the present financial year. This sum includes £80,000 grant to aided schools, irrespective of scholarships and maintenance of scholarship holders.

The Council has itself established seven training colleges, with accommodation for 1,900 students in training.

VI. *Technical Education.*—The work of polytechnics, technical institutes, schools of art, science, art, and commercial centres, and ordinary evening schools is all being co-ordinated. These institutions, apart from their day work, provide education for 200,000 evening students. The work ranges from repairing the defects of elementary education to education of a university standard, students in some of the polytechnics working as externals or internals for the degree of the University of London.

The cost of the Council's own technical institutes and schools of art was £53,541 in the session 1906-7, while in the same session £87,249 was paid to aided technical institutions, including the twelve polytechnics. The ordinary evening schools cost £135,880.

CHINESE STRAW BRAID.

About ten years ago almost the entire straw braid trade of the province of Shantung was done through the old-established houses of business in Chefoo, but with the completion of the railway from Tsingtau to the interior of the province, and the improved facility for transportation of braid thereby, the trade has been entirely diverted to Kiaochow, with the consequence that Tsingtau is now the largest straw braid emporium in China. The straw generally used in the province of Shantung is that obtained from wheat. Small farms are found throughout the entire province, varying in size from twenty square yards to sometimes several acres. The cultivation is carried out in the same manner as has been done for hundreds of years. No special precautions are taken to protect the wheat or to improve its quality, and the crops are dependent entirely upon weather and other natural conditions. The methods of cultivation have not passed the rudimentary stages. According to the American Consul at Tsingtau the manufacture of straw braid is confined to certain districts, and the quality of the braid produced is largely dependent upon the condition of the year's crop of straw. The crop of straw is cut with hand knives, the wheat or barley is sold for milling purposes, and the straw is bought up by straw dealers. These straw dealers sort the straws into lengths and qualities. The straws from the farmers are approximately four feet in length, but up to one foot from the roots is considered unusable, and the foot or so near the top of the stalk, after cutting off the head, is used for thatching purposes, and is sold by the straw dealers to the country people for that purpose. This leaves from two to two and a half feet of straw which is available for making braid. The straw dealers clip from the straws all pieces which can be used for first quality braid, pieces varying in length, four to five inches being generally sufficiently clear and perfect for this purpose; occasionally longer pieces are found, and in years when an exceptionally good crop has been obtained, these longer pieces are more frequent. The remainder of the straw is

used for the manufacture of the poorer qualities of plait. The straw dealers dispose of their straw to the plaiters either as whole pieces of straw of the required quality, or split into strips. For the splitting process, small roughly-made knives are used, having a point about one inch in length, which is inserted, and the straw easily split into two, four, or seven pieces of equal length. The plaiting of the braid is carried out in certain districts of Shantung, and especially in and about the Sha River, known as the "Sha ho district." This district consists of a series of small villages and farms, and it may be safely stated that almost the entire community, men, women and children, are engaged in the plaiting. Hardly a villager can be seen without his bundle of straw under his arm walking about the streets, or sitting upon the door-step, or that of his neighbour, industriously plaiting. It is said that the quality of the plait is largely affected by the weather and the feeling of the people, so that a superior quality is made in the summer, when the plaiters can remain out of doors in the sunshine. In the winter, when the extreme cold of Shantung confines the people to their houses, the braid is liable to be affected by the smoke of the lamps, charcoal fires, with their fumes, &c. The fact that all straws must be wet during the plaiting also affects the manufacture, as during the winter months, which are dry and cold, it is more difficult to handle the straws. The plaiters have no other occupation than this, and find sufficient work for the whole year, although during the four or five weeks when the straw crop must be gathered, they stop plaiting and assist in the fields. The quantity of braid that a plaiter can make is dependent entirely upon the quality of the product. Split plait, the kind usually sent to the United States, takes, according to width, from two to six days to make a piece of sixty yards. Split plait, from ·39 to ·43 of an inch in width, will average about two days work for the average plaiter for a sixty yard piece, while the finer braid, measuring from ·19 to ·23 of an inch, would probably take five or six days. This is particularly due to the fact that a plaiter cannot work so long on the finer grades of work, and in some cases will not do more than one or two hours work a day on special quality goods, but will continue working on some inferior quality as a rest. The pay of plaiters is very small, and it is almost impossible to get any definite idea of the income of a plaiter, as it depends largely on the skill of the workman, the number of people engaged in the work who are members of one family, the cost of straws, &c. The plaiters buy their straw from the dealers, and sell the manufactured braid to straw braid brokers, who pass through the villages at more or less regular intervals, and either purchase what braid is available, or make contracts with the plaiters for supply a certain quantity of the quality of braid required. Braid is sold entirely by the Chinese "chih" or foot (about 14 inches), by the plaiters to the brokers. The Chinese dealers in the interior, who are situated in the larger cities of the district where the braid is manufactured, purchase from the plaiters, and prepare the goods for sale to the foreign buyers. These dealers send their brokers throughou the district, either making contracts for the manufacture of the kinds of braid they require, or buying what is available on the market, that is, what they are able to pick up already finished by the plaiters. This purchased braid is bought in its various odd lengths, varying from a few feet to many yards, and sorted into its various qualities. Where places are found which are off in colour, or not up to the standard quality, they are cut from the piece, and the braid is thus sorted into the different qualities which have become known to commerce. A bundler then goes through the piles, and connects the pieces together until he has a total length of thirty, sixty, or one hundred and twenty yards, according to the kind of braid which he is working upon, and when the required length is completed, he rolls the braid into the skeins in which it appears on the market. Braids vary in width from ·11 of an inch, which is probably the finest braid that can be made, to 1·18 inches, or over. It is packed in bales, covered with straw matting, and a bale contains two hundred and forty pieces, and costs approximately one shilling per bale for packing. Split braid, or the more expensive kinds, is packed in boxes containing four hundred and eighty pieces, and costs, for packing, about three shillings and ninepence. During the time that the braid is in the hands of the up-country dealers, it goes through its bleaching process. It is hung in small tightly-closed rooms for a day or two, exposed to the fumes of burning sulphur in specially prepared tin boxes. The complete art of bleaching has never been discovered by the Chinese, and large quantities of the straw braid, exported from China, are sent to England, where they are re-bleached. Previous to the opening of the port of Tsingtau by the Germans, almost all the straw braid used on the Continent was shipped to England, re-bleached here and re-shipped to the Continent, but at the present time most of the braid intended for the Continent is shipped directly from Tsingtau. Braid is occasionally shipped from China direct to the United States and then sent to England for bleaching purposes, to be returned to the United States, but the more usual method is for American buyers to ship such braid as needs re-bleaching direct to England, and after bleaching it is shipped to the United States. The Chinese interior dealers transport braid to Tsingtau almost entirely by the recently constructed German railway. The packages are carried by wheelbarrows or Peking carts from the interior town to the railway station, and are unloaded in Tsingtau and transported to the dealers' warehouses at that port. Each dealer has his agent and warehouse at Tsingtau, and the foreign firms buy directly from these agents through the ever necessary comprador. Each of the foreign firms in Tsingtau has its regular agents in the United States or Europe, for whom it buys upon telegraphic advices. On the

receipt of a telegram the firm's comprador is informed regarding the quantity and variety of braid that is desired, and the probable price that can be paid, and the comprador goes directly to the interior dealers' agents to find out at what cost he can secure the required braid. All purchases are made through the medium of this comprador, and the foreign firms never deal directly with the dealers or their agents except in this way. In the event of sales, the comprador is paid a commission of 2 per cent. of the amount of the purchase by the up-country dealers, the foreign firms paying their comprador no wages or commissions. It can be easily seen that the success of a firm is dependent largely upon the success of the comprador in securing the goods at the desired price. Each of the foreign firms is supposed to have one of their number who is an expert and has had a training in the straw braid business. Naturally the firms who are so fortunate as to have experienced men are the ones which are most successful in this business. Straw braid is manufactured to a very large extent in the province of Shantung, and also in Shansi, Honan, and Chihli, and is exported from Tientsin, Tsingtau, and Shanghai, though practically all of that which is exported from the latter place is really produced at Tsingtau, collected, sorted, and repacked only at the place of export.

SMALL HOLDINGS.

The interim report of proceedings under The Small Holdings and Allotments Acts for the six months ended June last, is encouraging. It was feared by many well wishers that two difficulties would prove fatal to the success of the Act, (1) the unwillingness of landowners to grant the land necessary, and (2) the inability of applicants to find the necessary capital to work their holdings. With regard to the first point it is of course true that the Local Authority has the power of compulsory purchase, but many Councils might not be willing to exercise it. The report says that the Carmarthen Council were the first to submit to the Board an application for an order for the compulsory acquisition of land under the Act, but whether it will often be necessary to submit these applications it is too soon to say. The majority of the County Councils have now practically completed their local inquiries, and they are therefore in a position to know the approximate area of the land required to satisfy the genuine demand, but as the Report points out it would have been useless for Councils, as a general rule, to negotiate for land until this information had been obtained. Up to the end of June the Board had received 17 schemes for the provision of small holdings, 13 of which have been approved. In the case of the Radnorshire scheme the land has been acquired from Lady-day last, and the tenants in this case are the first to obtain possession of holdings under the Act.

With respect to capital the report is unexpectedly reassuring. It says that "The question of equipment, which has been commonly supposed would prove the great impediment to the creation of small holdings at a reasonable rent, has been much exaggerated. In the great majority of cases the applicants do not ask for horses or buildings, and this is probably due to the fact that most of these are men who are already resident in the county, and who desire land within reach of their present homes." Moreover, "so far as the information received by the Board goes, it is evident that a large proportion of the applicants are thoroughly reliable men, and that the amount of capital they possess is greatly in excess of what was generally anticipated . . . . In the great majority of cases the amount is ample to enable them to cultivate properly the land for which they have applied." The Board has been asked by several councils what in their opinion is the minimum amount of capital per acre which should be possessed by applicants, but the Board have pointed out that it is impossible to lay down any general rule, as the amount must depend on the circumstances of each case, and will vary according to the method of cultivation proposed. The extent to which the original number of applications has been reduced after investigation varies in different parts of the country. In some centres the sub-committees have ruled out a number of applications from village tradesmen, carriers, &c., who desired land as an adjunct to their present employment, and the Board have issued a circular pointing out that the Act does not justify the adoption of such a course, and they have requested the councils concerned to reconsider such applications. At the date of the report over 2,000 acres of land had already been acquired, and negotiations were in progress in many other centres.

THE VEDDAS OF CEYLON.*

The Veddas may most conveniently be considered under three headings, Veddas, Village Veddas, and Coast Veddas, for it seems that at the present day the Veddas fall into three groups, characterised by different sociological features. The coast Veddas fish and have borrowed largely from their Tamil neighbours, while the village Veddas have, to a considerable extent, intermarried with the Cinhalese. But in spite of these lapses both groups retain the remains of their old clan organisation in the majority of their settlements, showing their connection with those less contaminated and wilder folk who have commonly been spoken of as "rock" or "jungle" Veddas. On

* Abstract of a paper read before the Anthropological Section of the British Association, at Dublin, 1908, by C. G. Seligmann, M.D.

the psychical side, the life of all Veddas is unusually limited in every aspect except one, namely, their regard for the dead, and even this regard, which attains the intensity of a cult, has given rise to no decorative art; indeed a number of crude drawings, for the most part of animals and men, executed on the walls of certain caves, were the only examples of decorative art seen, and personal adornment is at the lowest ebb. But although this cult has produced no pictorial or plastic art, it has given rise to a series of dances, often pantomimic, and so, perhaps, in the nature of imitative magic, but whether pantomimic or not, accompanied, except in exceptional circumstances, by offerings of food to the spirits of the departed. Though others take part in them, these dances are performed especially by men who have been trained to invoke the *yaku*, as the spirits of the dead are called, and the use of a ceremonial arrow, with a blade over a foot long and a short handle, is an indispensable feature to some of these ceremonies, in all of which the "shaman" becomes possessed by one or more of the *yaku* he invokes.

Finally, as to language: all Veddas speak Cinhalese, or a dialect of Cinhalese, with a predominance of *ch* sounds, which makes Vedda talk sound harsh, and has led to the belief that they have a language of their own; but in addition many Veddas have a small number of words which are not obviously Cinhalese, or are Cinhalese periphrases; these classes of words are specially used in hunting and in addressing the *yaku*.

THE SMYRNA SPONGE TRADE.

Sponges are found about the islands of Rhodes, Syme, Kalymnos and Cos, while Smyrna is usually the place of market. Sponges are also found near Sicily, on the north coast of Africa and in the Red Sea. All these not only compete with each other in the world's markets, but they have some difficulty in holding their own against the sponges found among the West Indian Islands. Sponge fishing, according to the American Consul at Smyrna, is the most important industry of the inhabitants of the islands lying off the main coast of Asia Minor. Thousands of seamen every year are busy cleaning, drying, and bleaching sponges, a work which is not often of a pleasant nature, considering the number of lives lost in stormy seas and in diving. When sponges are first torn from the sea bed, they are of a dark colour, and living. By trampling and pressing them with the feet a milky substance oozes out, whereupon the sponge dies. They are then immersed in the sea for a space of eight or ten hours. The dark skinny substance is then removed by scraping and gradually, through cleaning, drying and bleaching, they take on the fine yellow colour which characterises many of them. It is said that the sponges taken from deep beds are better than those found in shallow waters.

HOME INDUSTRIES.

The Cotton Trade Crisis.—As anticipated, the ballot of the spinning and cardroom operatives has resulted in a large majority in favour of resistance to the reduction in wages of which the Masters' Federation has given notice. It does not follow that there will be a lock-out, but the dispute has reached an acute stage, and if a strike is to be avoided there is no time to lose in making the attempt to reconcile the contending parties. Both sides seem to have a strong case. The employers point to the depressed condition of trade and to the rates of pay which remain at the highest point in the history of the trade. No section of the trade is prosperous. Comparatively little yarn can be sold either at home or abroad, and prices are unremunerative. The immense increase in the producing power in recent years, an increase as apparent on the Continent and in America as in England, has so increased the production of yarns and goods as to go far beyond the world's power of consumption, and competition between the different countries for the raw material on the one hand, and for orders for the mill product on the other, have eaten into profits, until prices have been beaten down to such an extent as to entail loss on practically all business offering. This, roughly stated, is the employers' position, and it is a strong one, but the men have an answer that seems equally strong. Even some of the large producers of yarn and cloth think that the action of the Federation has been unwise. They argue that the effect of an extended short time movement should have been awaited before risking a conflict with labour, which if pushed to its extreme must drive important customers into the hands of foreign competitors. As to the men, they do not deny that the state of trade is very bad, and they acquiesced without demur in the short time policy devised to improve it. They, as they say, and they alone have hitherto felt the pinch of the hard times, for while their wages have been greatly reduced through the reduction in their hours, the shareholders continue to receive handsome dividends These dividends will continue for some time to come, and in some cases they are assured for years. For three years past the mills have been coining dividends until at the end of last year 100 spinning companies publishing balance-sheets showed average profits of £1,300,000 and paid average dividends at the record rate of nearly 16 per cent. Morever, the men contend that a reduction of wages, such as proposed, will amount barely to 1-16d. per pound on the price of yarn; that that is no remedy for the admitted great disparity of the cost of raw material and the prices which are now obtainable for the spun article, and they are willing to bear their share of the burden by working short time on any scale necessary to bring about an equilibrium. Further that the adjustment to a better basis is rapidly approaching through the coming abundance of cheaper raw material allowed by the marketing of an enormous American crop. In 1905 the employers conceded a

bonus of 5 per cent. for three months. Suppose the operatives now agreed to some temporary concession for a like period? By the end of the year the position may have cleared, and an abundant cotton crop, and reviving trade, may enable the employers to see their way to maintain the present rate of wages.

Shipbuilding on the Thames.—The reply of the First Lord of the Admiralty to Mr. Crooks, M.P., who had asked him whether he would be able to give repair work for the Navy to Thames firms, in order to alleviate distress, is not encouraging. "The plan of giving work to private firms," says Mr. McKenna, "has already been tried, and proved so expensive that it had to be abandoned." This experiment in making repairs in private yards was made in the financial years 1901 to 1906, when a large number of ships were so repaired in order to relieve the congestion in the dockyards, and it was officially stated at the time that the experiment had proved very successful. However that may be, it is clear from Mr. McKenna's letter that there is no likelihood of its early repetition. Almost all the great firms which have built men-of-war on the Thames in past years have gone. The Thames Ironworks, at Blackwall, which has constructed many fine ships, including the battleships *Duncan* and *Cornwallis* and the *Albion* for the Royal Navy, and the *Shikishima* for Japan remains, but the last ship built at that yard was the armoured cruiser, *Black Prince*, launched in 1904. It would be impossible to build destroyers on the Thames, for the building of these vessels is a very special business undertaken only by a few firms. There used to be two destroyer building firms on the Thames, those of Messrs. Yarrow, at Poplar, and Messrs Thorneycroft, at Chiswick, but both have been driven by economic conditions to leave the Thames. Competition has become so keen, that a firm, in order to hold its own, must work in a centre where everything required is ready to hand, and that is not the case on the Thames. It is possible to build on the Clyde—where Messrs. Yarrow have gone—over 12 per cent. cheaper than on the Thames, and Messrs. Thorneycroft have found it to their advantage to open a yard in Southampton Water.

The Patents Act.—Our foreign rivals, more especially in Germany, are much incensed at the enforcement of the Patents Act. It seems to have been thought, more especially in Germany, that diplomatic action would be able to prevent its enforcement, and now that it is seen that the British Government intend to enforce it, disappointment and annoyance are keen. Threats of reprisal are natural, but it is not easy to see how retaliation is possible. The Patents Acts of other countries, and more especially Germany, are already as stringent as they well can be, and that leading German firms have no belief in the possibility of reprisals is shown conclusively by the fact that they are erecting or buying plant in England, or, as a further alternative, are co-operating with British firms. The view of patent agents is that the Act does not benefit the British inventor. In some ways it does the reverse, since it introduces an element of doubt as to the validity of his patent by extending the period for the entry of opposition to his invention from two months to two years. And as it was hinted in these Notes last week, it may not prove an unmixed blessing to the British manufacturer if it quickens competition at his doors. But there seems little room for doubt that it will confer a great benefit on British labour.

Wire Netting.—Some time ago the manager of the St. John's Galvanised and Black Iron Netting Works, Sydney, addressed a complaint to the Australian newspapers which attracted considerable attention. It was that the Company was unable with a 5 per cent. duty to compete against imported British wire netting, which, according to the manager, was of inferior quality. The manager has now written another letter on the same text in which he gives six reasons, among them patriotism, why the Australian pasturalist and agriculturist should buy his company's netting rather than the British article. The manager of the Australian works argues that the user ought not to mind a few pounds per ton when this extra payment will support an industry, which gives good wages to Australian workmen. A more serious argument, to which the attention of British manufacturers of wire netting may usefully be directed, is that the Australian article is "loose-rolled," and therefore easier and less costly to erect. "All imported netting is very tightly rolled and compressed to reduce the cost of freight. This very materially damages the netting by opening up the twist and salvage, and cracking off the zinc coating, which is the 'life' of the netting." If there is anything in this complaint it ought to be easy to remedy it in these days of low freights.

Tramway Accounts.—The tramway accounts of the city of Glasgow for the year 1907-8 are interesting, as showing the results achieved by a well-managed municipal enterprise. The total increase was £916,565, or 10·593d. per car mile. Traffic expenses accounted for 2·966d., or 28 per cent. of the expenditure, the item including wages, cleaning of cars and track, and fuel and power for the car depots. General expenses, mostly due to the cost of management, printing, law, and insurance, accounted for 1·055d., or nearly 10 per cent. General repairs and maintenance of rolling stock, track, and buildings cost 1·418d., or nearly 14 per cent. Power expenses, including fuel, wages, salaries, and repairs, but not capital charges, accounted for only 0·454d., or little more than 4 per cent. The total working expenses thus amounted to 5·893d., or about 56 per cent. Capital charges required an expenditure of 4·250d., or 40 per cent. Of this expenditure 2·180d. was required for depreciation and renewals, and 1·409d. for interest and sinking

fund. These figures show how large the capital charges are, and how important it is to reduce idle plant and buildings to the minimum. The net balance remaining was 0·45d. per car mile. Sixty per cent. is about the proportion of the total income expended upon traffic expenses for both tramways and railways in most parts of the world.

OBITUARY.

SIR EDWARD BIRKBECK, BART.—Sir Edward Birkbeck, who became a Member of the Society in 1882, died on Wednesday, the 2nd instant, at Horstead-hall, in Norfolk. Sir Edward, who was created a Baronet in 1886, represented in Parliament one of the divisions of Norfolk from 1879 to 1892. He took a keen interest in fishing matters, and was one of the originators of the Fisheries Exhibition of 1883. He acted as Chairman of the Executive Committee of this Exhibition, and was afterwards led to take an active part in the series of Exhibitions which followed —Health, Inventions, and Colonial.

He served on the Council of the Society almost continuously from 1884 to 1903, when his failing health caused him to give up this, as well as much other public work. As a Member of the Council he became a Member of the Royal Commission for the Chicago Exhibition, 1893, and took an active part in its organisation, visiting Chicago whilst the Exhibition was in progress. He was Chairman of the Royal National Lifeboat Institution for many years, and took a large share in its management. On three occasions he presided at meetings of the Society.

GENERAL NOTES.

FLORENCE ART EXHIBITION.—An Exhibition of Painting and Sculpture will be held by the Society of Italian Artists at Florence from the 1st November, 1908, to 30th June, 1909. Foreign artists will be permitted to exhibit subject to certain restrictions.

TURIN INDUSTRIAL EXHIBITION, 1911.—An International Industrial Exhibition will be held at Turin from April to October, 1911. The Exhibition will comprise sections devoted to education, mechanics, electricity, photography, colonisation, national defences, measuring instruments and apparatus, public works, transportation (railways and tramways), mercantile navigation (sea, river, and lake), aerial navigation, postal services, sporting industries, modern town (dwelling, decoration, furniture), agricultural and forest industries, food industries and products, wearing apparel and leather industries, jewellery, printing, &c.

THE COMMERCIAL INTELLIGENCE DEPARTMENT. —It is satisfactory to find that business men are beginning more generally to recognise the assistance that may be rendered to them by this department. In 1906, 5,544 enquiries were made. In 1907 the number increased to 9,166, and during the present year enquiries have been received at the rate, roughly, of 30 a day, or 10,000 a year. The putting of specific questions has a valuable effect in keeping the department and its correspondents oversea up to their work, and it may be expected that the number of enquiries will be increased now that Australia, New Zealand, and South Africa—in addition to Canada—all have their resident British Trade Commissioners.

TANTALUM.—*The Engineer* reports that Ekeberg, the Swedish discoverer of tantalum, gave that name to the metal because of the tantalising difficulties that he encountered while investigating it. It is only recently that tantalum has been obtained in a state of purity, and the rapidity with which it has been produced in response to the demands of commerce and industry is almost unprecedented. Only a little while ago the mineral from which tantalum is obtained was so rare that not enough could be found to supply specimens to all the mineralogical museums. Now Australia alone produces more than 70 tons of tantalite a year. This does not seem a very great quantity, but it is to be remembered that a single pound of tantalum suffices to furnish 23,000 lamps, each of 25 candle-power.

TRADE IN PERSIA.—In his report on the trade of Bunder Abbas and Hingah (4076, Annual Series), Lieut. C. H. Gabriel, His Britannic Majesty's Consul for the district, says that large numbers of letters are received at the Consulate from business firms desirous of opening up communication with trustworthy Persian merchants with a view to the introduction of appliances and articles more or less in demand in civilized countries. The Consul says that in the present backward state of the country, the absence of roads, sanitation, or houses other than those constructed of mud or brick, and the prevailing ignorance regarding the most elementary kinds of machinery, such applications are premature. In any case it is necessary to exercise extreme caution in opening business relations with Persian traders, as their trade customs too often allow a latitude from which it becomes easy to merge into fraudulent bankruptcy. There are in the town some 40 or 50 British-Indians, representatives of native traders in Karachi and Sind. These sell goods on credit to Persian traders, and derive profits therefrom which more than compensate them for losses continually sustained by reason of absconding dealers. The British-Indian traders, however, are obliged to order their consignments through the medium of Karachi business houses, which course involves the delay of some months in delivery.

Journal of the Royal Society of Arts

No. 2,913. VOL. LVI.

FRIDAY, SEPTEMBER 18, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE THEORY AND PRACTICE OF CLOCKMAKING.*

By Sir Henry Hardinge Cunynghame, K.C.B.

PART II.

I now propose to put before you the method of calculating the time of swing of a pendulum. In this endeavour, I have to choose between simply giving you the results from text-books, or also the proofs of those results. And in giving the proofs, I have had to decide whether to abridge them, or to give them more fully. Upon reflection, I have resolved upon the latter course, partly because I do not think you will find in most of the books the proof given in a connected form such as is useful to the scientific clockmaker. For I have here brought together information which is usually scattered over more than one book. If the reader finds it tedious, he has but to omit it, and those versed in mathematics will of course, at a glance, be able to skip any portion they please.

On the other hand, those in whose memory dynamics are not so fresh, may perhaps find this short exposition useful, and I hope they will find it correct and clear.

The Simple Pendulum.

The investigation of the motion of a pendulum demands some mathematical considerations. To simplify the problems, we shall first treat a pendulum as though it consisted of a rod without mass or weight, terminated by a bob, which, though it has mass and consequently weight, may be a mere point. The conditions of motion of such a pendulum having been determined, it will then be possible to adapt the formulæ to suit a compound pendulum, that is a pendulum having size and mass in all its parts.

The notion "time" is elementary, and we can neither define or explain it. It is the measure of the rate of change. Whether it is an objective reality, or only due to the character of our human thought, we cannot tell. We cannot put it back or forward, nor magnify it with any form of microscope; nor can we conceive of its beginning or end, or its non-existence.

Space, in some respects, is a more simple conception than time. In other respects, it is more complex. It has three dimensions—length, breadth, and thickness, and no more—nor can we imagine space of four dimensions. It embraces all material things. Change of place in time is called motion. There are two principal sorts of motion—translation and rotation. Both of these present great difficulty of conception; for, from one point of view, all motion is relative. Thus, for instance, if two points are receding from one another, who is to say which of them is the fixed one and which the one in motion? Annihilate one of them, and the other ceases to have any motion at all. At first sight, therefore, it would seem that no such thing as absolute motion is possible. But Newton, in his "Principia," advances reasons against such an idea. For he instances water, contained in a round bowl, capable of being whirled round on its axis. At the commencement of the motion, the water remains at rest, that is at rest with regard to the room, the earth, or the universe. Relatively to the rotating vessel, the water is moving, but the surface remains level. Now, as the vessel continues to rotate, the water gradually acquires motion from the vessel, and finally becomes at rest with regard to the vessel, and in rotary motion, with regard to the universe. Are we to regard the water as absolutely in motion, or no?

At first sight it might appear that the question was only a question of words. If we choose to consider the universe as at rest,

* The Course consisted of Six Lectures, delivered Jan. 20, 27; Feb. 3, 10, 17, 24. In re-arranging the material for publication, the Lecturer has preferred to divide it into Four Parts.

then the water is moving, but if we choose to consider the bowl at rest, then the water is at rest. According to this view Galileo might have easily compromised his dispute with the inquisitors, for he might have said that the earth was at rest absolutely though in motion relatively. But this simple manner of cutting the gordian knot is not really permissible.

For a phenomenon is observable which seems to determine the question. When the water is moving relatively to the universe, it becomes concave on the surface. No amount of motion merely relative to some part of the universe seems to produce this effect. To what is this due? We know not. It may be that to produce the phenomenon of centrifugal force on which the concavity of the surface of the water depends, it is necessary that the water should move relatively to the ether by which all bodies are pervaded, and that the ether in general does not partake of the motion of matter. If so, then if the ether could be set whirling with the matter, the centrifugal force might disappear, and the stability of our cosmical system might prove to depend on the stationary character of the ether. Or, again, stationary matter might exhibit a centrifugal tendency if the ether in it were in a whirl. Just so two similar bar magnets, laid side by side, are repelled as though by the whirl of the ether vortex round them. These conditions would be very difficult to produce for experimental purposes, and are out of the range of mechanics at present, for the purposes of which we are obliged to regard motion as of two sorts—absolute and relative—and for dynamics it is usually of absolute motion that we speak. For some, at least, of the laws of motion and such phenomena as those of the gyroscope depend on the motion of which we are speaking being absolute either as regards the heavens, or, at least, as regards some arbitrarily selected portion of it.

By the mass of a body we mean the quantity of matter in it. The density of a body is estimated by comparing the mass of a body with its bulk, assuming for the purposes of mechanics that all matter consists of the same substance more or less closely packed together. Hence, the mass of a body is found by multiplying its volume into the density of the substance of which it is composed. The density is found by finding the specific gravity by weighing the body in water in a manner subsequently to be described.

Velocity or speed of motion is used to express the rapidity of motion with regard to time. That is to say the space traversed in a given time or the time taken to traverse a given space. Thence the ratio of the space traversed to the time taken to do it is a measure of the velocity. Expressing this idea in an equation, we have the expression $s = vt$ where s is the space traversed in a given time t, and v is the velocity. These letters of course do not represent the actual things they stand for, but only represent numbers. You cannot multiply a velocity into a time in order to get a space, any more than you can multiply men into loaves of bread, when one says that if each man eats 2 pounds of bread a day fifty-six men will eat a hundredweight. One may express this generally by saying $m \times b = X$, where m is the number of men, b the amount of bread each can eat in a day, and X the total daily consumption of bread. But in this equation m does not mean 56 men, it only means 56, so that in reality all equations are numerical, and thus depend on assumed units. We may of course change these units. 1 lb. of bread is about ·45 kilos.; hence if, instead of pounds of bread we were to take kilos., the answer would work out; m (men) $\times$ kilos of bread consumed by each man $=$ kilos. consumed by the company. In changes of unit, we must always be careful to preserve dimensions. Thus, if the weight of a man varied as the cube of his height, in changing our equation from feet into metres, we should have to divide not by 3·279 but by the cube of 3·279, so as to take care that each of his dimensions, viz., height, breadth, and thickness, had its due change of unit.

We have now defined motion, velocity, and mass.

By momentum is meant the quantity of motion contained in a massive body. It is estimated by multiplying the mass into the velocity. A body with a slow velocity may have more momentum or quantity of motion in it than a body which moves more rapidly.

As will presently be seen, a body having momentum is usually capable of exerting force. The expression for momentum is $m\,v$. It may be reckoned positively or negatively. This definition of momentum or quantity of motion shews us at once that momentum must not be confused with velocity. A light body might have a very high velocity in the term that it was rapidly traversing space, but its motion, *i.e.*, the quantity of motion, or in other words the momentum, might be small. On the other hand, the momentum or quantity

of motion in a glacier is enormous, though its velocity is exceedingly small.

By acceleration, we mean rate of change of velocity; that is to say, change of velocity in time. Just as change of space, as compared with time, is velocity, so change of velocity, as compared with time, is acceleration or "quickening." Hence then, as regard space, we may say that velocity is the rate of change of place, but acceleration is the rate of change of velocity, that is the rate of change of the rate of change of space. It is the rate at which the rate of change of place changes. Expressing this in mathematical language, we have $v = ft$ where f is the acceleration, and v the velocity. Whence if as we previously said $s = vt$, we shall have $s = ft^2$. From which we may therefore expect that in motions in general, where any quickening of the velocity is going on, the spaces passed through from rest will vary as the squares of the times taken to traverse them. It is only when the velocity is constant, that the space traversed from rest varies as the time of passage. For if the velocity is uniform, the space traversed varies as the time, but if the velocity itself be increasing with the time, then, as the body proceeds, not only does the space passed over increase, but the rate of increase itself increases, and thus the space passed over depends, in a double degree, on the time that has elapsed.

We have now to consider force, one of the most simple conceptions at first sight, but which, on examination, proves to be full of difficulty. The usual definition of force, given by the great masters of physics, is a cause that produces, or tends to produce, or to prevent or retard, or tend to retard, motion; and force is of various kinds. When it is applied to a body whose resistance to motion the force is unable to overcome, it is a pressure, as when a weight presses on a table. It is, however, to be observed that in this case our definition compels us to regard not merely the weight as pressing downwards on the table, but the table as pressing upwards on the weight. Pressures, therefore, always come in pairs. A pressure unbalanced becomes a motion, which always takes place, to some extent, when the body pressed upon is at all free to move. The branch of mathematics which deals with the actions of pressures on bodies at rest is called statics, and embraces such problems as the lever, the wheel and pulley, screws, and other stationary mechanical contrivances.

The next kind of force that may be distinguished consists of impulses or blows. These are distinguished from pressures in that they produce motion, but are regarded as instantaneous in character. In truth, there is no such thing as instantaneous communication of motion. All communications of motion, even of the most violent kind, take some time. The notion of an "impulse" or instantaneously created motion is an artificial one, and is dealt with mathematically by treating an impulse as a force which rapidly ceases to act, and whose results alone are examined, without considering the stages by which those results were brought about. Thus, when an elastic ball strikes another, time is taken for the rebound, just as time is taken for the rebound when someone jumps upon a spring mattress. We may always, if we please, treat forces as impulses, or sets of impulses, provided it be remembered that we are in so doing employing a convention.

The third sort of forces are those which exert gradual influence upon bodies either to accelerate or to retard them. When a body is acted upon by such a force and is free to move, it acquires velocity, and if the force continues to act the velocity is increased, and experiment leads to the conclusion that velocity can as it were be poured into a body indefinitely, so that as each standard period of time goes on the velocity becomes greater and greater. The mysterious attraction of matter for matter is an example of such a force. The dragging force of a locomotive engine is another, the pull of a horse is another. The force of the wind is the pressure of water, the attraction of a magnet, are all examples of such forces.

It may be objected that if I push forward on the floor a heavy box that offers considerable resistance, the velocity of its progress is slow, sometimes stops, and at all events does not increase. How then can I be said to be exercising an accelerating force? The answer is that any pushing force is opposed by a force due to the friction of the box on the floor, which opposes mine and occasionally equals it and stops me; for a time converting the accelerating force of my push into a pressure. It is true it never overcomes and pushes me back, for frictional force is of such a character that it is only developed by an opposing push. Cease the push and you cease the frictional pressure. It is only when another mass, or a powerful spring opposes me, that it can sometimes not only stop me but even push me back. None the less, however, is my push an accelerating force. It is like the force of an engine gradually imparting increasing

motion to a train. As the increase of velocity proceeds, an opposing force is brought into play by friction which is not merely proportional to the velocity, but which after a certain speed increases more rapidly than the increase of velocity. So that the retarding acceleration of the train to motion increases with the motion until the point of equilibrium is reached, when the train runs on at a uniform speed.

This method of regarding force is not altogether free from difficulty. To the beginner it seems rather artificial. If I push against a wall, as the wall cannot move, I create a pressure. I can stop or regulate this pressure as I please. But the wall cannot stop its pressure. My will seems to be able to command not only my body to press against the wall, but to direct the wall to press or to cease from pressing against me. There seems no reciprocity about the processes. This is true; but for mathematical purposes we are not bound to enquire why the wall presses or what makes it do so, or whether it is some will, or some activity. Sufficient it is for the purpose of mathematical calculation that for some reason or other it does press, and so long as it does, the question of the circumstances under which it would cease to do so if other pressures ceased, is immaterial. Thus then we have three sorts of forces. Statical pressures which do not produce motion, but only "tend" to produce it; impulses or blows which communicate motion instantaneously, and moving forces, as Newton called them, which cause accelerations of velocity in those bodies upon which they act.

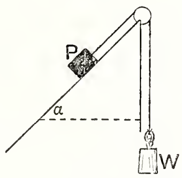
The most prominent example of pressures are those produced by the action of gravity. The attraction of gravity has been proved experimentally to be proportional to mass. Much confusion has been produced both in ancient and modern times by misused ideas of mass and gravity.

The ancient philosophers, perhaps with the exception of Lucretius, thought that there were two principles in bodies, one of heaviness that tended to urge them to the earth's centre, the other of lightness, which urged them away from that centre towards the sphere of the stars. Earthy bodies they thought were attracted to the earth's centre. Fiery bodies were repelled from it, while water and air, partaking of the nature of both earth and fire, exhibited intermediate characteristics. Following this principle out they thought that heavy bodies must fly towards the earth more rapidly than lighter ones. They never reflected that though a heavy body is attracted by a greater force than a light body, that there is a greater mass of matter to be moved which thus takes up and utilizes the greater attraction. They do not seem to have considered the obvious fact that if two equal balls of lead, when put side by side, fall to the ground in a certain time that they cannot be made to go faster merely by tying them together, or melting them into one. This oversight led them away from a true conception of the nature of force, and induced errors which it took a considerable part of Galileo's life to remove.

In modern times common usage has perpetuated some of the errors. When we speak of a pound of tea we mean a mass of tea that has as many ultimate particles of mass in it, as a unit mass of some standard substance such as platinum. We do not mean 1lb. weight of tea. The mass of tea would still be 1lb., and would make as much infusion and be as useful, on the surface of the moon, where, owing to the diminished attraction of gravitation, it would only weigh $\frac{1}{6}$th lb. Of course, to show that it weighed less in the moon we should have to use a spring balance. For if a common pair of scales were taken to the moon both brass and tea would have their weight diminished in like proportion, and the tea would still balance the 1lb. brass weight, though both tea and weight really exerted less pressure. At the moon a man could easily jump over the head of another. He would go up more slowly and come down more gently. He would feel as though inflated with gas, and could knock a cricket ball over the tallest church steeple. But it would come down gently, and when thrown about cricket balls in the moon would only seem like balls moving in water. Hence, then, the pressure exercised by a mass of matter is a totally different thing from the mass of matter itself. This may also be seen clearly by placing a mass on a perfectly slippery inclined plain. The force exerted down along the plane by the action of gravity will not equal the force exerted vertically by gravity. It will, as we know, only be equal to the weight of the mass multiplied by the sine of the angle of inclination of the plane. $P = W, \sin \alpha$. Again, suppose that two equal weights W and W′ are hung over a pulley, and that on one of them is placed a smaller weight w, then if the pulley has no weight nor friction, the pressure on a table on which W rests will be w, but the mass of the whole system which

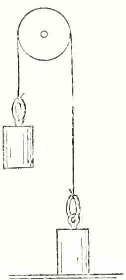
would move of the table were removed is not W, but is W + W′ + *w*. So here again you have a force produced by the action of gravity on a mass *w*, and yet obliged to move a total mass = W + W′ + *w*;—

FIG. 7.



showing clearly that by contrivances of various sorts the attraction of gravity can be made to act much less effectively on the mass of a body than when it gets a fair straightforward pull at the mass, on which occasion it is at a maximum.

FIG. 8.



The estimation of gravitational attraction will do well enough for the measurement of masses, when we are dealing with pressures for statical purposes, that is to say, when bodies are not in motion. In that case and for those purposes a pound weight of tea is a pound mass of tea.

But when we have to deal with motions, we can no longer treat forces as pressures, because as motion is possible, they are no longer pressures, they have become motions of masses, with various velocities. If we are dealing with impulses or blows we estimate as we should estimate the action of cannon balls by their masses and velocities, or, in other words, by their "momenta," and we utilize the observed fact that on the impact of all bodies elastic or non-elastic, and whether they remain together after impact or fly apart, the sum of the momenta, or, in other words, the quantity of motion in them, taken altogether, remains unchanged.

But when we are dealing with moving forces, *i.e.*, forces that move bodies by means of gradual pushes or pulls or attractions, and when our object is to discover, not the final result of some blow that begins and ends almost instantaneously, but the gradual effect of a force that endures for a long time, perhaps over the whole of the motion, we must have a new mode of computation.

The method here adopted is characteristic of the phenomenon which it is designed to study. For when a body is in motion under the action of no external force, it will move uniformly in a straight line with that velocity for ever. And when a body is moving on a curve, if all force ceases to act on it, it will not go on in a curve, but will go on in a line tangential to the curve with a uniform velocity such as it had in the curve when the action ceased. The tendency of a body at rest to remain at rest, or if in motion to go on uniformly in a straight line, is called inertia. Inertia may be regarded as a property of matter. It is by reason of inertia that bodies only respond feebly to feeble forces. Any force, however small, applied to a body free to move will move it, but the amount of the movement will depend on the mass of the body to be moved. Inertia is, therefore, proportional to mass. It might be called a velocity-absorbing property, for when the inertia is great the communicated motion seems to be swallowed up and to produce but small velocity, but the motion is there, and can by suitable means be again converted into the rapid velocity of some smaller body.

The result of this is that when a body (such as a pendulum bob, or the earth in its orbit) is moving in a curve it must be because some force is continually acting upon it and drawing it away from the straight path which, if uninfluenced, it would always pursue. And, again, it also follows that if a body is changing its speed it must be because some force is acting upon it during the whole time of the change, and either urging it to go forth, or retarding it so as to make it go slower than the uniform pace at which, but for the force, it would always travel. Uninfluenced motions are always straight and uniform. From this it also follows that moving forces acting on bodies give them motions which if in a straight line are regularly increasing or diminishing, or which, if they are not in a straight line owing to the moving force acting obliquely, and more on one side than another of the natural path of the body, are curves gradually bending round like the beautiful flight of a ball constantly drawn out of its rectilineal even path, by the constant downward pull of the

earth's gravitation, which acts sideways or obliquely on the path of the ball except only when it is shot vertically upwards, in which case gravity acts along the path of the body as a retarding force, and though the gravitational attraction leaves the form of the path of the body a straight line, yet it makes its speed become slower and slower till it gets to the top of its flight, and then faster and faster as it descends, instead of allowing it to pursue the uniform path which its nature desires.

These observations naturally lead to the inference that "moving forces," *i.e.*, "forces that gradually move bodies," are measured by observing the changes of movement that they are capable of making—in other words by their accelerating effects upon bodies. The acceleration would be expressed by saying that the moving force had in one second of time, and while acting along some definite direction, produced in that mass an acceleration (or retardation) of so many feet per second estimated along the aforesaid direction. The effect of any given accelerating force on a body varies inversely as the mass of that body; the more mass there is to be moved the less acceleration will be produced in its motion. Whence then, suppose that an accelerating force is such that acting for a second upon a unit of mass (*e.g.* 1 lb.) in any direction, it will induce a change of velocity in that direction of f feet per second, we call it f; and when it acts upon a mass of m units we call it $m f$, meaning by $m f$ the number of units of mass affected, multiplied by the acceleration which would have been produced on a unit mass by the action during 1 second of the force in question. Therefore f is a general term independent of the mass of the particular body that may happen to be subject to its action, and $m f$ is the force producing the acceleration f on the mass m.

It has been seen that there are three sorts of forces; namely: static or pressing forces, impulses, and moving forces.

A single cause may often be considered under all three of these heads. For instance, suppose we had a spiral spring which, when pushed in for an inch, reacted with a pull equal to one pound weight, which means that if a mass of 1lb. were put upon it the weight of that mass due to the action of gravity would compress the spring by one inch. Then, considered from a statical point of view, we might say that the pressure exerted by this spring was equal to one pound weight.

If, however, we pressed the spring and put it close up to a ball of mass m, and then by pulling a trigger let it suddenly fly out and hit and propel the ball, we might, by considering the ultimate result of the impulse, estimate the force of the spring by saying that when it had done its work and the ball had just left it, the velocity v imparted to the ball was some definite quantity of feet per second. In this case the blow or impulse given by the spring would have resulted in a momentum or quantity of motion $= mv$. A ball half the size would have been shot out with a greater velocity. Here we should have estimated the force exerted by the spring by observing the momentum it could impart to a given mass by the total effect of its impulse.

There is, however, yet a third way. We could estimate the value of the force of the spring by placing it in contact with a very heavy ball which it could not move rapidly, and then observing the rate of change of acceleration that the spring would produce.

In the first of these methods, the method of observing pressures, we should observe the effect of the spring before and apart from any motion of the body affected by it. In the second, the method of observing momenta, we should observe the effect produced by the spring after its driving effect had been completed and had ceased. In the third, the method of observing accelerations, we should observe the acceleration produced upon the mass by the action of the spring during the period of that action.

It is obvious that each of these methods has its advantages. If you wanted to know the pressure of a head of water, you would employ the first of these methods. If you wanted to know the projective force of a cannon upon a shot you would employ the second method, and if you wanted to know the attractive force of a new planet, the third method. For observation of the effect of its force on accelerating the motions of other bodies, would be your only resource.

In our investigations into the motion of pendulums it becomes certain that the third method must be employed because we do not start or keep them swinging by blows, but on the contrary try so far as we can to compel them by gentle and gradual moving forces.

Let us illustrate these conceptions by examining the fall of a body from rest under the action of gravity. The force of gravity varies

as the mass on which it is exerted. It is such that in one second it induces on a body that is free to move a velocity of 32·2 feet (= 981 c) per second, and, as we have seen, this velocity is independent of the mass of the body because each part of the mass may be considered as if it were falling separately. The value 32·2 feet per second is usually written g. When the body has fallen for a space of one second its velocity is therefore g feet per second.

Now, the force of gravity near the earth's surface is approximately uniform, and produces a uniform acceleration of velocity as compared with time. Therefore, at the expiry of t seconds the velocity of the body will $= gt$, and since its acceleration is uniform its average velocity during the period of t seconds $= \frac{1}{2} gt$. From this it follows that the total space it will have fallen through in t seconds $= \frac{1}{2} gt$ (its average velocity) $\times$ t (its time of fall) $= \frac{1}{2} gt^2$.

The earth's gravitational force as given above is for a place close to the surface. Inasmuch as the earth is not a sphere we may expect to find that the value of g varies for different places. As a fact, it varies according to latitude. Its value for any latitude is found by the formula—$g = \gamma$ $(1 - \cdot 002662 \cos 2 \phi)$ feet per second per second where γ is the value of g in latitude $45^\circ = 32\cdot 1718$, and ϕ is the latitude. In London the value of g is 32·19078 feet per second per second, that is to say, when gravity acts on a body near the earth's surface at London and free to move, then during each second of its action it will increase the velocity of that body by 32·19078 feet per second (= 981·18 centimetres per second). The student must be prepared for some differences in the books as to the value of g. It has, in fact, never been measured in a wholly satisfactory manner. Thus, another formula for computing g given by Helmert is—$g = 980\cdot 617 (1 - \cdot 002644 \cos 2 \phi + \cdot 000007 \cos^2 2 \phi)$, where ϕ is the latitude of the place, and diminishing the result by ·03 for each hundred metres of the place above the level of the sea.

Before we commence the investigation of the motion of a particle along a straight line or upon a curve under the action of moving accelerative forces, it is necessary to remind the reader of the method by which such investigations must be conducted. It is the method devised by Newton for the purpose, and called the method of infinitesimals.

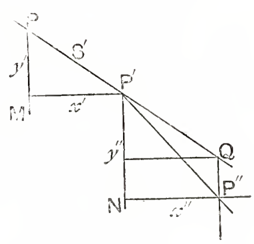
According to this method, when a body is moving along a curve under the influence of a force varying according to some law, instead of trying to examine its motion during some definite of time, we examine its motion during a very small time and along a very small period of its path.

It was Newton's discovery, that if we so restrict the area of our investigation, then during that small bit of the path traversed in that small time, we may consider curves as straight lines and forces and velocities as uniform; that is to say, if we infinitesimalise the times and spaces, then we may treat curves as straight lines, and velocities and accelerations as uniform.

This grand generalisation brought all problems concerning motion within the domain of mathematics. It was exactly analogous to the method first seen by Archimedes and other Greek geometricians, of treating a regular polygon with an infinite number of sides as a circle, when those sides become infinite in number.

If then P P′ be two successive positions of the particle and the distance PP, be traversed in a time t', then the space passed through may be called s', and the components of this space measured along the axes of x and y, may be called x' and y'; and if the

Fig. 9.



velocity of the particle resolved along the axis of x be v, and its acceleration be f, then during the short path from P to P′, traversed in the short time t', we may treat the velocity and acceleration as uniform, whatever the real law of the variations in those quantities may be. And the paths, whether direct as PP′ or resolved along any direction, as PM, P N may be considered as rectilinear.

The problem then becomes, supposing the particle to leave P in the direction PP with a velocity supposed uniform from P to P′, what effect will the action of the forces have on it during the period t, supposing those forces during that period also to be treated as

uniform? Of course, a series of parallelograms of velocity answers this question; and once we can determine a general expression for them, then by a process of integration we can collect up into a whole the small effects so determined for an infinitesimal portion, provided we know how to conduct that process of integration correctly.

Of course, such a triangle as P M P′ is elementary. Its shape is only true for the particular point P of the curve. When we come to take the next adjacent element, P P″, the direction may have changed, and the velocity and acceleration also. Thus, for instance, instead of going on from P′ in a straight line to Q, it may by the action of some force be deflected to P″. In that case the ratio of y'' to x'' would no longer be the same as y' to x'. The path would be bent; and if P P′ P″ are all infinitely close together, the path P P′P″ would become a curve. It may, however, be objected that if you can cause P P′ to coalesce, why not P″ also; and why will the whole curve not become a point? The answer is, that by the process of integration above referred to an infinite number of nothings are added together. It is quite true that the addition of an infinitely small quantity to another infinitely small quantity will still leave the result infinitely small if done any finite number of times, but if you do it an infinite number of times you then get a finite quantity again. In fact, the chief use of these infinitely small triangles is to consider tendencies and changes and laws of motion. If I wish to learn the character of a change that is going on, I can study it better by observing a small point with a microscope than attempting to envisage a large area with a telescope; for once admit that the law of the change is the same everywhere, and at all points of the curve, and it becomes obviously easier to investigate its character over a tiny area than to attempt to obtain the law by an encyclopædic grasp of vision. If we could be convinced that some law of vegetable growth were everywhere and in everything the same, we should have a better chance of discovering it by the study of one cell than by attempting to observe the whole vegetable world. It is in the power given by concentrating attention on an infinitesimal part that resides the success of the Newtonian method of calculating motions by the method of infinitesimals.

(To be continued.)

THE MAPPING OF BRITISH AFRICA.*

In entering upon the discussion on the survey of British Africa, the first point that meets us is the geodetic basis of the whole work; upon what do the actual positions depend? In other words, to put the matter more familiarly, how are we to provide that every isolated piece of the map will exactly fit into its proper place? The only method for ensuring this is by basing all our surveys, ultimately, upon a skeleton or framework of geodetic or primary triangulation executed with the utmost attainable precision. Such a skeleton, or rather backbone, will eventually exist in Africa in the shape of the meridional arc, or chain of triangles, along the thirtieth meridian, running right through the country from north to south, and ultimately joining on to the great arc observed by the famous astronomer Struve. This originally extended from the mouth of the Danube to Hammerfest, in Norway, an amplitude of $25\frac{1}{2}°$ of latitude. To prolong it southward, passing up the Nile Valley, through the heart of tropical Africa, across the Zambezi River, and terminate it at the southernmost point of the continent, is a magnificent conception due to Sir David Gill, to whose energy and enterprise the actual execution of considerable sections of the undertaking must also be ascribed.

At the present time the chain has been completed from the south to within 70 miles of the southern end of Lake Tanganyika, a distance of about 1,700 miles. At Lake Tanganyika it will enter into German territory. The German Government, fully recognising that the project is not only of great theorectical interest, but also of immediate practical value, are already taking steps to start work on their own section, from the south of Tanganyika up to the parallel of 1° south latitude. From 1° south, northward to about $1\frac{1}{2}°$ north, the arc lies near the boundary between the Congo Free State and the British Protectorate of Uganda. An International Commission is at present engaged in the survey of the boundary region, and Sir D. Gill, ever ready to seize an opportunity of forwarding the work he has at heart, succeeded in raising sufficient funds, partly from the Treasury, and partly by grants from a few leading scientific societies, to enable an observer to be sent out with this Commission to carry the arc over this section. North of this point the line comes into the territory of the British Soudan, and traversing this eventually reaches Europe proper. Here it comes into the charge of Captain H. G. Lyons, the director of the Survey Department of Egypt, under whose care its interests are safe.

It will thus be seen that while the actual completion of the whole chain is as yet somewhat remote, we are in the satisfactory position of being able to say that, as far as the section lying on the continent of Africa is concerned, there is no portion of which there is not a reasonable probability that it will be

* Extracted from the Presidential Address of Major E. H. Hills to the Geographical Section of the British Association, Dublin, 1908.

finished within a measurable period. With regard to the section joining Africa and Europe the position is not so happy. This will run through Palestine and Asia Minor and therefore lies in Turkish territory. It is not likely that the Turkish authorities either will or could carry out such a work; in fact, seeing that even when completed it would be totally useless to them, it would be hardly reasonable to expect them to do so. It must, therefore, presumably be a matter for international co-operation. One point may be mentioned with regard to the exact route of this connecting section. Sir D. Gill, in his report on Geodetic Survey of South Africa, 1896, said "By an additional chain of triangles from Egypt along the coast of the Levant, and through the islands of Greece, the African arc might be connected by direct triangulation with the existing triangulation of Greece, and the latter is already connected with Struve's great arc of meridan which terminates at the North Cape in latitude 71° N. The whole arc would then have an amplitude of 105°." This, however, gives rather a poor connection with the European triangulation. The South Albanian series has a much higher average error than either Struve's original work or any part of the African series. This portion would consequently be a weak link in the geodetic chain, and it would be better to avoid it altogether by carrying the line along the coast of Asia Minor to Constantinople, and then up the east side of Turkey to the mouth of the Danube.

When we look back a few years and call to mind the prominent part that this country has taken in the survey of Palestine—I need only mention in this connection the names of Kitchener, Warren, and Conder—we cannot avoid a feeling of regret that we are not ourselves in a position to take the whole execution of this section of the line upon our shoulders. I am too well aware of the many urgent claims upon the Treasury to suggest that it is possible that they would be prepared to incur such a charge; but supposing, for the moment, that part of the necessary funds could be provided from other sources, I think we may fairly urge that it is our duty to contribute a substantial monetary grant towards the furtherance of an end so desirable and so practically useful.

The difficulty of obtaining money for geodetic work, the benefit of which is not immediately apparent to the man in the street, is notorious. Thus Sir T. Holdich, in 1902, said: "But this accurate framework, this rigorously exact line of precise values which ultimately becomes the backbone of an otherwise invertebrate survey anatomy, is painfully slow in its progress and is usually haunted by the bogey of finance. It does not appeal to the imagination like an Antarctic expedition, although it may lead to far more solid results, and it generally has to sue *in formâ pauperis* to Government for its support." To account for this regrettable, but undoubtedly true, fact two reasons may be adduced. There is, in the first place, the possible ignorance as to the ultimate value of the work; but, secondly, and perhaps not least, there is the fear, not entirely unjustified, that to satisfy the demands of the scientific man is something akin to the operation of filling a sieve with water. It has been so often seen that compliance with one demand only leads to another being made, that we may well sympathise with the holder of the public purse when he draws the strings tight and refuses to pay for an arc along the thirtieth meridian in the fear that directly this is completed he will be asked to pay for one along the twentieth meridian, and then along the tenth, and so *ad infinitum*. It behoves us, therefore, as practical men to make sure that our demands are reasonable and limited to the actual requirements of the case, and where such limits cannot be set we should make this fact clear at the outset. When, however, it is possible to set such limits, we should not hesitate to do so; and in the case of the African arc this latter course is fortunately possible.

If we take the map of Africa we shall see that the arc along the thirtieth meridan passes through, or near, all the colonies of British South Africa, close to British Central Africa, or Nyasaland, through Uganda, and is thus connected with British East Africa, through Egypt. There remain absolutely untouched by it only the West Africa colonies—Nigeria, the Gold Coast, Sierra Leone, and the Gambia. These latter will eventually get their geodetic framework by an extension southwards of the French triangulation of Algeria, a work of a high order of precision. We are, therefore, entitled to say—and I take this opportunity of saying it with all due emphasis—that with the exception of some triangulation to join the West African colonies with the French triangulation, the arc along the thirtieth meridian is the only primary triangulation required for the adequate mapping of the whole of British Africa. The remainder of the geodetic framework can be supplied by ribs of secondary triangulation branching out from the main backbone, such as the line already completed along the boundary between British and German East Africa, passing to the north of the Victoria Nyanza and thence westward to the thirtieth meridian.

You will observe that I here speak only of the triangulation required for mapping purposes, not of that demanded by the geodesist for the study of the figure of the earth. The latter is satisfied only with a survey of the highest attainable precision covering as large an area of the earth's surface as possible, or at all events with arcs, both meridional and longitudinal at frequent intervals. It cannot be other than a very long period before the whole of Africa is surveyed upon this scale of accuracy, and in the meantime we must devote ourselves to the far more urgent duty of mapping the country, leaving the more remote and abstract task to our descendants, well satisfied if in our hands the foundations have been well and truly laid.

Furthermore, as we shall see presently, if we are prepared to recognise as a national duty the minutely precise survey of our own land and of all territories

under our flag—and I do not see how any reasonable man can withhold this recognition—then there are duties of this nature lying closer to our hands than any to be found in Africa.

Having thus passed in brief review the ultimate geodetic basis of our African surveys, let us enter more into detail and glance at the actual survey work now in progress in the different regions of the continent.

In British South Africa, as we have already noted, the political conditions are at present unfavourable to any comprehensive scheme of operations. There is however in progress a first-class topographical survey of the Orange River Colony and a reconnaissance survey of Cape Colony. The former is an excellent example of the class of work that can be done by a small military party of the highest technical training working upon systematic lines, and I should like to devote a few minutes to a short description of the methods adopted and of the results obtained.

The survey party consists of two Royal Engineer officers and four non-commissioned officers, the former undertaking the triangular and the general supervision of the field work, and the latter the plane tabling. The positions are primarily based upon the points of the geodetic survey broken up into a secondary triangulation with sides averaging ten miles. In 1907 the average triangular error of the secondary work was 2·9 seconds of arc, and the greatest linear errors of displacement, as tested by the geodetic triangulation at the end of a chain forty-five miles long, were three feet in latitude and two feet in longitude. The probable error of a trigonometrical height was under a foot. You will see therefore that the accuracy is ample for all mapping purposes, even upon large scales, and the degree of precision is in excess of that demanded for a topographical map on the scale of two miles to an inch. The rate of progress and the low cost of work are, however, no less notable than its accuracy. The actual rate of out-turn is about eight square miles per day per man, or for the whole party twenty-three square miles of detail survey per diem, and the number of trigonometrical points fixed about three hundred per annum. The cost works out to about eight shillings per square mile of the completed map, and the whole area of 47,000 square miles will be finished, printed and published, in five and a half years.

These remarkable results are due in a large measure to the energy and organising power of the officer in charge, Capt. L. C. Jackson, R.E. The detail survey is done in sheets fifteen minutes square, each non-commissioned officer being given one complete sheet, which he works at until finished. Four such sheets are therefore in progress at any given time, and each sheet takes about six weeks. Seeing the rapid rate of progress maintained it might perhaps be thought that the country is a particularly easy one for the topographer. Such is, however, by no means the case. It is true that there is an entire absence of the surveyor's greatest impediment, large areas of dense forest, but there is much broken and difficult country, rising in places to altitudes of above 7,000 feet.

In Cape Colony the reconnaissance survey is of a somewhat similar character, but owing to the large area of the country and to the small amount of money available the work has perforce to be of a more rapid nature. In Natal, Bechuanaland, and Rhodesia, no survey is at present in progress.

Passing northward through Africa, we come to the British Protectorate of Nyasaland, formerly called British Central Africa. Of this country a certain number of maps exist purporting to give topographical detail; but as they are not based upon any framework of triangulation, and as much of the detail only depends upon rough sketches, it is impossible to say how far they can be accepted as correct representations of the ground.

It is most unfortunate that financial considerations prevent the execution of any systematic trigonometrical survey. The absence of such, and the fact that maps are being made which must inevitably be withdrawn and replaced by others in the future, will undoubtedly be the cause of ultimate waste of money.

Passing northward again we come to the large and important protectorates of British East Africa and Uganda, in both of which systematic surveys are in hand. The geodetic framework is supplied by a triangulation along the Anglo-German boundary, connected with chains of triangles along the railway in the neighbourhood of Nairobi. In Uganda proper there is also a triangulation covering a substantial area. As already noted, all this work will eventually be tied into the thirtieth meridional arc, though it is not likely that the final adjustment of geodetic positions thus arrived at will necessitate any substantial alterations upon the maps.

In both protectorates topographical surveys are in hand, and maps on the scale of two miles to an inch will be issued. In British East Africa, under the able direction of Major G. E. Smith, R.E., rapid progress is being made. This topographical mapping is additional to the cadastral maps also in progress in both countries. These latter are required for property purposes, in Uganda for demarcating the estates given over to the native inhabitants of the country under the agreement of 1900, and in East Africa for attachment to title-deeds of lands alienated for farming or stock-raising.

In the Soudan, the enormous area of the country—over a million square miles—and the limited funds available, have prevented any systematic survey being taken up. A large amount of reconnaissance mapping has been done, and a series of sheets on the scale of 1/250,000 (four miles to an inch) have been published. These are corrected and improved by officers and Government officials as opportunity offers. The energies of the Survey Department are almost entirely spent in meeting urgent local require-

ments in the shape of cadastral maps of the cultivated areas along the river.

Somaliland, a British protectorate which came into unfortunate prominence a few years ago, is a country of too small value to be worth the cost of any sort of survey, and the only maps that exist are based upon the route sketches of travellers and sportsmen, and upon the work done by a small section of the Survey Department of India during the military operations five years ago.

Leaving the east side of Africa and turning our eyes westward, we may note that in the colony of the Gold Coast a rigorous survey was rendered imperative by the gold-mining boom of 1901. The work was entrusted to Lieut.-Colonel Watherston, C.M.G., R.E. Owing to the dense forest covering practically the whole country, triangulation would have been prohibitive in price and very slow in execution. The initial positions were therefore fixed by a network of long traverses, executed with all possible refinements with steel tapes and theodolites. Astronomical latitudes were observed by Talcott's method at every fifty miles. The errors of misclosure of the traverses proved to vary from about 1 in 2,000 in unfavourable cases to nearly 1 in 6,000—results inferior to triangulation, but at the same time sufficiently accurate to form the basis of a map with no appreciable errors *on the paper*. One great defect of the traverse method of fixing points lies in the practical impossibility of carrying the heights through without occasional checking, either by lines of levels or by trigonometrical observations. Such work makes therefore an imperfect basis for topography, and would only be used when natural features compel its adoption.

Northern Nigeria is a country of enormous area, and, up to the present, of small revenue. It has therefore not been found possible to allocate the funds for any systematic mapping. The existing maps are compilations based upon sketches made by civil and military officers when travelling upon duty and upon the surveys made by the different Anglo-French and Anglo-German boundary commissions. In 1905-6 Captain R. Ommanney, R.E., fixed the astronomical longitudes of fifteen towns by exchange of telegraphic signals with Lagos. With the aid of these values, combined with a number of astronomical latitudes, it has been possible to combine the material into something like a complete map. It need, however, hardly be pointed out that astronomical fixations are liable to large and uncertain errors, due to the variation of local attraction, and cannot attain the precision of even a rapid triangulation. In Southern Nigeria the experience has been somewhat unfortunate. This colony has spent a very substantial sum upon its survey department, and if the work had been properly organised and systematically carried out, we should by now be in possession of a complete map of a large portion of the country. Unluckily, the mistake has been made of detaching survey parties for non-geographical purposes, such as the erection of telegraph lines, work doubtlessly urgently required in the interests of the colony, but not lying within the sphere of a survey department. Thus systematic progress was rendered impossible, and, though isolated pieces of triangulation and long lengths of traverses have been done, no topographical map of any area yet exists.

Of the remaining West African colonies, the Gambia river is a narrow piece of land with boundaries running parallel to the river banks, and, except for the actual trade along the river, is unimportant. In Sierra Leone, the country in the immediate vicinity of Freetown was surveyed by the colonial survey section, a small party employed by the War Office for the purpose of making surveys of places of special military importance. The map of the remainder of the colony is a compilation based on miscellaneous material.

In the course of this summary of the state of the mapping of British Africa mention has been made of the surveys made by joint commissions appointed for the delimitation of international frontiers. No small part of the existing map is due to work of this class. Thus joint Anglo-French commissions have marked out the frontiers of the Gambia, Sierra Leone, the Gold Coast and Nigeria; Anglo-German commissions the eastern boundary of Nigeria, the boundaries between British and German East Africa, between German East Africa and North-East Rhodesia from Lake Nyassa to Tanganyika, and between Bechuanaland and German South-West Africa; Anglo-Portuguese commissions the frontiers between Portuguese East Africa and North-East Rhodesia and Nyasaland respectively. Useful surveys have also been made in the course of the mutual demarcation of the frontiers between Abyssinia and the Soudan on the west and British East Africa on the south; also of the frontier between the colony of Sierra Leone and the Republic of Liberia.

Important as the work done by the commissions has been, its value would be greatly enhanced if the reports of each commission were published in a succinct and easily accessible form. Such reports would naturally contain a record of the actual frontier as finally ratified, and also a technical account of the survey methods employed. They would thus be of permanent use both to the official or officer on the spot for the easy settlement of any disputes that may arise, and to the chief of any future boundary commission as an aid to the selection of the methods of survey most suitable to the particular country with which he is concerned.

The account which I have endeavoured to give you, short and imperfect as it is, of the present state of the mapping of British Africa, will have shown you clearly that there is a large amount of excellent work now in course of execution, and that there has been, especially during the last few years, very considerable progress made towards co-ordinating this work, and towards maintaining certain fixed standards of accuracy, rapidity and economy.

It will naturally occur to you to inquire whether the co-ordination could not advantageously be pressed a step further, and whether all the isolated survey departments, now working in the various colonies and protectorates, could not be amalgamated under one head, whether, in fact, a Survey Department of Africa, precisely analogous to the Survey Department of India, could not be formed. The advantages of such a step are obvious, but must not be allowed to blind us to the difficulties. We have, in the first place, the objection to be met that the South African colonies would, under present circumstances, almost certainly refuse to join in any general scheme, and would not consent to any arrangement whereby money raised in one colony would be spent outside its own geographical limits. If, however, we leave South Africa out of the question, the financial difficulty tends to disappear. Both our East and West African possessions are, in general, not yet in a position to maintain themselves, and are still, and will be for some time to come, partially supported by grants from the Imperial Treasury. To divert a portion of these grants to pay for the maintenance of a survey department would only be a matter of account aud could be adjusted so as to cause nohardship to any one colony. There remains the geographical difficulty of space. The fact that the heads of the department would have to keep in close personal touch with countries differing entirely in character, and perhaps three months journey from each other, does not appear to offer any insuperable objections, and I cannot avoid expressing the hope that it may be found possible at no very remote date to take some steps in the direction of a consummation which appear so desirable.

In giving my evidence before the Royal Commision on the War in South Africa, presided over by Lord Elgin, I outlined the general features of a scheme under which the Imperial Government would undertake the topographical mapping of all our oversea possessions, apart from the self-governing colonies. As on this occasion I was considering the whole question more exclusively from the military side, no reference was then made to the question of cadastral maps, and it was tacitly assumed that these would fall to be constructed by the land office or a land survey department belonging to each separate colony. On the present occasion we are not restricted to the military point of view, but are permitted a wider outlook. Our task is to consider the map in all its aspects, both as regards its method of construction and its ultimate use, whether for military, administrative, engineering, or purely scientific purposes. This enlargement of our scope does not, I think, modify our previous conclusions, and were I now called upon to devise a scheme for the mapping of British Africa, I should base it upon the principle of a central Imperial body for executing the triangulation and topography, leaving the land survey to local organisations

HOME INDUSTRIES.

The New Patents Act.—It is seldom that an Act of Parliament works quite as its authors and supporters hoped and expected. The Trade Marks Act is one of the most striking illustrations of this truth. It may be that the New Patents Act will be another. It may bring the foreign competitor to even closer grips than at present with our manufacturers, and it may lead the inventor to resort more frequently to the secret process. The chief drawbacks to patenting an invention are two—(1) the publication of its nature; (2) the limitation of the protection afforded (except in very exceptional cases) to fourteen years. On the other hand secret working is open to two fatal risks, (1) it may be betrayed by an *employé*; or (2) it may be guessed by an outsider. But assuming that the secret can be kept—as it has been with not a few important inventions—it gives the inventor an indefinitely prolonged monopoly, and he may at any time, when the risk of discovery becomes imminent, apply for a patent and so extend his monopoly for another fourteen years. For the fact that the invention has been used commercially does not impair his right to a patent provided there has been no publication beyond confidential disclosure of the invention to those engaged in working it. If, however, while the original inventor is working his invention secretly it is discovered by another manufacturer who also works it secretly, then neither the first inventor nor his rival can subsequently obtain a patent for it, since to grant it to the one would be to debar the other from doing something that he had previously been doing. Prior to the Act of last year it mattered not how the later user came by his information, the fact that he had it was fatal to the inventor's claim to a patent. But now, as a correspondent of the *Times* points out (September 9), in virtue of Section 41, Sub-section 2 of the new Act, the risk of invalidation, owing to publication arising from disclosure through a breach of confidence, is entirely eliminated. This is a new provision intended doubtless to meet cases of hardship arising from the premature publication of an invention either through breach of faith or accident. But its effect will be much wider. It will give the original inventor a fourteen years' extension of his monopoly, and having obtained his patent he will apparently be able to sustain his exclusive right to the use of the invention even against the person who was employing the patented process at the date of the patent. Thus the principal risk to which secret working has hitherto been exposed would seem to be removed, and the inducement to adopt this course of working greatly increased. Independent discovery is now the only risk menacing a monopoly based on secret working, and the risk of independent discovery is usually not great, it is at least much smaller than that consequent upon betrayal or accident. It is quite possible, therefore, that one of the results of the Patent and Designs Act, 1907, will be largely to increase the number of inventions worked as secret processes.

Small Holdings.—It is probable that as a result of last year's Small Holdings and Allotments Act many landowners will deal directly with the applicants for small holdings or allotments rather than wait for action by the county councils, and expense as well as delay may be saved thereby. In many cases the land for small holdings is being relinquished by the present or former occupiers voluntarily at a much earlier date than would have been possible if it had been necessary to give formal notice. All the evidence tends to show that the Act will be the means of creating a large number of small holdings, and where the conditions are favourable it may be expected that the occupier will do well. Colonel Raikes, agent for Lord Beauchamp's estates in Worcestershire and Warwickshire, has just given an interviewer some interesting particulars of what can be done with fruit culture. At Binton there are thirty acres of land covered with fruit; they are let in acre and half-acre plots. "It is," says Colonel Raikes referring to the site, "on a hill side so conveniently situated as regards railway facilities that the tenants have only to put the fruit and the vegetables (which are grown in between the fruit trees) on to their hand barrows and trundle them down to the station with the greatest ease. As showing how profit can be made by the allotment holders out of what would be wasted by larger growers, a few seasons ago, when there was such a tremendous crop of plums that the larger farmers allowed them to hang on the trees and rot because they would not go to the expense of having them picked, an allotment holder made £6 out of 120 pots of plums picked by his wife and children, which would have cost a farmer 8d. a pot to get gathered." The holder of an allotment on the Hertford Estate is an auctioneer's porter, and when he is not attending cattle or furniture sales he works on this allotment, which he has held continuously for 14 years from the Marquis of Hertford. He sends the bulk of his fruit to salesmen in the big towns, but most of his garden produce he can dispose of advantageously close at home. And so with others. But it would be erroneous to assume that small holdings would be profitable to occupiers in all parts of the country. Suitable soil and nearness to a market are indispensable conditions to success. Given these, and unremitting and intelligent industry, profitable working may be safely predicated.

The Railway Position.—It is not surprising that railway shareholders, many of whom are dependent for their livelihood on their half-yearly dividends, should be loudly bewailing. It is not only that they are suffering from diminished incomes, there has been serious shrinkage in the value of their stocks even when those stocks are those of the most prosperous of the companies. For example, at the end of August, 1907, the price of North-Western Stock was $154\frac{1}{2}$; on August 31, 1908, it was $132\frac{1}{2}$. Taking the same period, Great Western Stock has fallen from $130\frac{1}{2}$ to 119; Midland Deferred from $66\frac{1}{2}$ to 56; Great Northern Deferred from $47\frac{1}{4}$ to $42\frac{1}{2}$; Great Eastern from $83\frac{3}{4}$ to $63\frac{1}{2}$; Great Central Preferred from $38\frac{1}{4}$ to 21. The facts of the position do not seem to warrant these serious declines. Railway traffics, if lower than in the "boom" of last year, are not below the normal. The high price of coal has been a serious matter for the companies, but there is ground for the expectation that prices will reach a much lower level before long, and the coal bills of many of the companies will be appreciably smaller this half year than last. A good deal is said about the prejudicial effect of the Miners' Eight Hours Bill, but, in the first place, it has still to become law; and in the next if, as many experts affirm, the Act would not affect the cost of coal production, though the immediate effect of its passing might raise and keep up prices, competition would soon bring down prices. Another consideration that weighs with many is the possibility of increase in the labour bill, but that is not at all probable at present. When some of the Conciliation Boards meet they will have to consider claims on the part of the companies for reductions in the wages of some grades, and this is not the time when the men, if they are well-advised, will clamour for higher wages. No doubt the dread of a strike or lock-out in the cotton trade is having a disturbing effect, and if, unhappily, it comes about, it must have a disastrous effect upon the traffic of the several railways that serve the Lancashire district; but the dispute between masters and men has now been whittled down to such a small point that it is reasonable to expect that an agreement will be reached. Again the disposition shown by some of the large companies to curtail competition is a hopeful sign. The arrangements proposed between the Great Northern, Great Eastern, and Great Central Companies, and between the London and North-Western and Midland Companies, do not seem to have impressed the public, probably because the somewhat similar arrangement between the South-Eastern and Chatham Companies has brought no benefit to the proprietors. But the failure here was due to the conditions imposed by Parliament, which prohibited the raising of rates and fares, although cutthroat competition left no profit. Whatever may be said from the point of view of the public in opposition to the amalgamation schemes now in negotiation, or just effected, it is pretty certain that they will benefit the stockholders. Altogether then it would seem that there is some justification for the contention that the stocks of leading railway companies are unduly depressed.

The Cotton Trade Dispute.—At the time of writing this Note, the wages dispute in the cotton trade remains unadjusted. The Conference held on September 10th, between the representative committees of the Federation of Master Cotton Spinners, the Amalgamated Association of Operative Cotton Spinners, the Association of Card and Blowing-room Operatives, and the Northern Counties Warpers and Winders, failed to come to an agreement, but they

got so near it that it is difficult to believe that a settlement will not be effected during the current week. At the Conference, the operatives' representatives began by suggesting a postponement until January, with the understanding that if trade continues to be bad they should recommend to their constituents the acceptance of their employers' terms. To this the employers would not consent, but proposed an unconditional reduction to take effect in January. The operatives would not agree to this without first consulting their members, but the employers would not consent to adjournment, and the conference broke up. It is not quite easy to see why employers should insist upon an unconditional reduction in January. Their expectation is that the reduction of stocks and the confirmation of good crop reports will by then have brought about a revival of trade. It is to be hoped that the two parties will be brought together again this week and a satisfactory compromise adopted.

CORRESPONDENCE.

"THE TANGLES OF TIME."

There are few things more trying to the sporting spirit in us than to be put on a keen scent, and in the same instant held hard back again; and thus straining, so to say, at the leash, I would wish to follow up, in a few brief sentences, the metaphysical speculations on "Time" with which Sir Henry Hardinge Cunynghame opens in the current number of our *Journal* his Lectures on "The Theory and Practice of Clockmaking."

(1) There is "Time" as an inherent conception of a postulated infinite, eternal, self-subsistent, omnipotent Intelligence, the creator, sustainer, helper, and deliverer of all things that exist, visible and invisible; and a modification of this inherent conception of Time, apparently postulated by Kant as subsisting in the mind of man as constituted in finite likeness of this supreme Intelligence. I say "apparently," for it is difficult for an Englishman to be sure that he understands Kant: but having all my life read Kant,—and my graduation thesis dealt with these things, and for the very reason that they are so difficult!—I can say that Sir Henry Hardinge Cunynghame expresses Kant's view of Time more explicitly and simply and clearly than any other writer with whom I am familiar; as will be admitted by any one who will consult such authorities on Kant, as E. Caird [*Philosophy of Kant*], Meiklejohn [*Critique of Pure Reason*], and Stirling [*Text Book to Kant*]. (2) There is time as duration, whether connected with spiritual or material existences, visible or invisible, or not, being in itself absolute, whether in relation to somethingness or nothingness. It is as absolute as space. There is no such thing as an eternal "now," not even outside the worlds upon worlds in motion throughout the Universe;—not even for Coplestone's "drop of water encased in a cavity of silex"! There must be "now" and "then"; and you can no more have eternity without "now" and "then," that is Time, than space without "here" and "there." Plato defines Time as the shadow of eternity; but that is poetry; Aristotle as "the measure of motion" and that is science. "There should be time no longer," apart from "the dispensation" to which it refers, is a dramatic phrase. (3) There is "Time" as marked by the succession of events, the order of the phenomena of Nature, &c. This is Time as viewed by Aristotle, and by Locke, by Monboddo [James Burnett, caricatured by Gilray], Reid, Dugald Stewart, all the philosophical Scots with whom metaphysics always has meant the most uncommon "common sense." For all scientific minds, "Time" is "the measure of motion,"—the heart-burst of the song of birds in Spring, the blossoming of the woods and fields in Summer, the ripening of fruits in Autumn, and the silent falling of the snows of Winter; and the human physiological periodicities of 28 days, and years of months of 28 days, and of months of 30-31 days; and again the sun in his stages marking out the hours of the day, and moon and planets of the night; and moon and sun together fixing the days of the m(o)onths, and the months of the year,—and yet more prolonged periods of "Time," extending to cycles of 12,000, already determined by human calculations.

In fact, the whole Cosmos, as known to science, is as one mighty timepiece that for all the past eternities through which it has been envisaged by man has shown no sign of wearing; its wheels within wheels, as of amber, and beryl, and "the terrible crystal," bearing their hierarchies on hierarchies of living creatures with them, still working as freely and brightly as when first they circled into space; and with every promise of so enduring through all eternities to come. I have, therefore, always regarded a clock as one of the aptest and most moving symbols of the Cosmos, viewed as the perfected work of its divine Maker, —"*el orlogiere eterno.*"

If I may presume to say so, Kant might have saved his reputation for "commonsense" had he included in his view of "Time" the view of Aristotle, as a subdivision; but, unfortunately, Kant's view is regarded as exclusive as that of Aristotle. This possibly arises from Kant's bewildering habit of giving new meanings to the old terms of the "Schoolmen" used by him. I may have bewildered the question yet more by carefully avoiding in these paragraphs the use of any of the technical terms of metaphysics. In my own view there is only one category, supreme and imperative, Being; and substance, quantity, quality, relation, place, time, situation, possession, action, and suffering are but "accidents" of it. GEORGE BIRDWOOD.

12th Sept., 1908.

Journal of the Royal Society of Arts

No. 2,914. VOL. LVI.

FRIDAY, SEPTEMBER 25, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

PRIZES FOR INDUSTRIAL DESIGN.

The Council of the Royal Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Committee of that fund in 1876, on condition of the interest thereof being spent in Prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damasks, Chintzes, &c., regulated by the principles laid down by Owen Jones."

Competitions, under the terms of this Trust, have been held annually since 1878.

The next award will be made in 1909, when six prizes are offered for competition, each prize to consist of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

The prizes will be awarded on the Report of the Examiners in the National Competition of the Board of Education, South Kensington, S.W., by the 1st of April, 1909. They must be marked "In competition for the Owen Jones Prizes, and must comply with the regulations of the Board of Education.

No candidate who has gained one of the above prizes can again take part in the competition.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE THEORY AND PRACTICE OF CLOCKMAKING.*

By Sir Henry Hardinge Cunynghame, K.C.B.

PART II.—(*continued*).

We are now in a position to be able to apply the conceptions which have been outlined above. In doing so I do not propose, of course, to range over the whole field of dynamics, but merely to select such parts of it as are needful to enable these conceptions to be applied to the solution of the motions of pendulums.

Let us suppose a particle of mass m, which is free to move, to be acted upon by a moving force, that is to say a force that acts on it not by an impulse, but gradually and continuously. The measure of such a force will be its power of producing acceleration of velocity in a unit of mass. Let this acceleration be f, that is to say let the force be such that if it acts upon a unit mass it will in some given direction produce an increase of velocity of f feet per second measured parallel to that direction during each second of its action. If we are treating only of the motion of a particle and merely wish to consider its motion and not the momentum that will be produced in it, we may for simplicity assume it to be of unit mass, being prepared if needful to put in its true mass afterwards when wanted. It is as though we selected for our experiments a ball of unit mass and of great density so as to be only a unit of mass without size. Then the

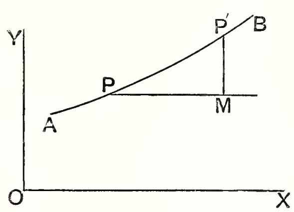
* The Course consisted of Six Lectures, delivered Jan. 20, 27; Feb. 3, 10, 17, 24. In re-arranging the material for publication, the Lecturer has preferred to divide it into Four Parts.

forces acting on it might be expressed simply in terms of accelerations, and the above force talked of simply as "f," always remembering however that f is in reality not the force, but the acceleration produced by it on the mass under consideration.

Let us now apply the method of infinitesimals. As the particle is to be acted on not by an impulse, but continuously, it will move not uniformly in a straight line as its inertia would prompt it to do, but in a curve; and probably with a varying velocity. Let A B be the curve and P a point in it. Let us examine its motion.

While the particle is moving during an infinitely small time t' suppose that it moves from P to P′, then if s' be the length of its path, P M will be the space it has passed through measured along the axis O X, and M P′, the space measured along the axis O Y. Put M P $= x'$ and P′ M $= y'$, then in accordance with what has been previously said, P M P′ may be treated as a rectilinear triangle.

FIG. 10.



Let v be the velocity at P resolved along O X and v' the change of velocity which is acquired during the time t', and, again in accordance with the method of infinitesimals, let us consider v' as uniform during the period t'. The accelerating force whose action on the particle we are going to investigate, may be either uniform, or else variable, and it may be either always parallel to some fixed direction, or else it may be directed to some fixed point, or else may be ever changing in magnitude, or direction, or both. But for the small time t' we may, (again in accordance with the infinitesimal method) consider it uniform in strength and fixed in direction. Let it act along the axis of X, and let its value, as said before, be f. Let v be the velocity at P resolved in the direction O X.

If, then, x' be the space P M and v the velocity at the point P, it is obvious from the definition of velocity that

$$x' = v\,t'.$$

But it may be asked why during the interval t' no account is taken of the acceleration of v. Why, in fact, if v' be the acceleration of v we do not average it and put $x' = \left(v + \frac{v'}{2}\right) t'$. In truth, this would be the more logically accurate method, but in accordance with the theory of infinitesimals, an infinitesimal like v' need only be considered when compared with other infinitesimals. When compared with or added to a finite quantity like v it may be left out, and it is all one whether we write v or $v + \frac{v'}{2}$.

But v', the increase of velocity during the time t' (which, considered as added to v, may be neglected) $= ft'$ when f is the acceleration in a finite time t.

These two general equations, $x' = v\,t'$ (1) and $v' = ft'$ (2) are, the fundamental equations of motion, and follow from the very definitions of motion and acceleration. It is necessary to be careful in the use of these infinitesimals. Though they lose their value when added to finites, as a grain of dust may be neglected when compared with the universe, yet considered as ratios they have their full value and meaning. In modern mathematics x' is usually written dx, t' is written dt, and v', dv, and care is taken not to treat them as quantities, but to introduce them in pairs as ratios. Thus we are to consider, not dx, but $\frac{dx}{dt}$ and not dv, but $\frac{dv}{dx}$ or $\frac{dv}{at}$; for it is only in their use as ratios that their peculiar properties become valuable. In short, infinitesimals must be treated as infinitesimals, and not used as concrete and definite quantities.

The equations are therefore written—

$$\frac{dx}{dt} = v \quad (1)$$

$$\frac{dv}{dt} = f \quad (2).$$ If we divide (1) by (2)

we have $\frac{dx}{dv} = \frac{v}{f}$ (3) which may be written $v\,dv = f\,dx$, provided we remember to treat dv and dx still as infinitesimals, and not use them separately as if they were finite. The above equations are mere generalisations. In order to use them we must now give value to some of the terms.

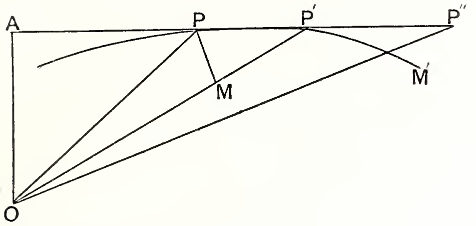
From the laws of Newton, general conclusions of great importance may be drawn.

1. If the only accelerating force acting upon a free particle always acts in a vertical direction, like gravity, then the motion of the body, resolved in a horizontal position, will be uniform.

2. If the only accelerating force acting upon

a free particle always drags it to a centre, like the attraction of the sun upon a planet, then, whatever the law of the attraction of the planet may be, the particles will sweep out equal areas in equal times.

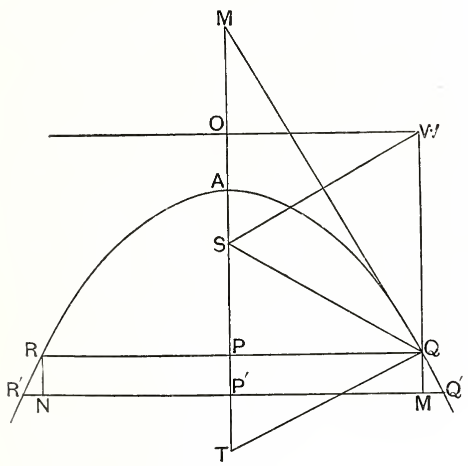
FIG. 11.



For if P P′ be its path during a small time, t', then, were it not for the accelerative force, it would in the next equal increment of time go on to P″, where P P′ = P′ P″. But, therefore, the triangles, O P P′, O P′ P″ are equal, and since the triangle, P′ M′ P″ is infinitesimal in comparison with O P′ P″, it may be neglected. Whence the triangles O P P′ and O P′ M′ are equal, which are the areas swept out in the equal times.

Let us now apply these principles to the vertical fall of a body under the action of gravity. By means of a geometrical figure the solution maybe made very easy. Let A be the point from

FIG. 12.



which the body falls down a vertical line, A T, and consider A T as the axis of X. From any points P P′, near together, draw P Q P′ Q′ to represent the velocities of the falling body, at the points P, P′. Then P Q $= v$ and Q M $= dv$ and P P′ $= dx$. And the curve A Q Q′ is such that its horizontal ordinates represent the velocities acquired by a fall from A down the corresponding abscissæ.

Produce Q′ Q to meet P A in M, and draw Q T perpendicular to it.

Now, from equation (3) above given for the general conditions of motion, $\frac{dx}{dv} = \frac{v}{f}$.

But $\frac{dx}{dv} = \tan QQ'M = \tan PTQ = \frac{PQ}{PT}$.

If the force acting on the body is that of gravity, then f is constant and $= g$,

$$\text{and } \frac{dx}{dv} = \frac{v}{g} = \frac{PQ}{PT},$$

But as $v =$ P Q, it follows that $g =$ P T, whence since g is a constant, so also is P T. But in a parabola, since S Q is always equal to Q W, they grow at equal rates, and therefore the tangent of the curve at Q is equally inclined to them, whence Q T, the normal at Q is always parallel to S W, and therefore P T is always equal to O S, and is therefore a constant. Hence, then, a curve such that $\frac{dx}{dv} = \frac{PQ}{\text{a constant}}$ must be a parabola, with g as representing the distance S O. Its equation is, therefore, $v^2 = 2gx$ where $g = 2$ A S, the distance of the focus from the vertex. This equation, therefore, shows us that if a body is let fall, its vertical velocity at any point x from the point at which it commences to fall $= \sqrt{2gx}$.

On the other side of O T we may draw a curve such that its ordinates from P P′ represent the times of fall from A to the points P P′, respectively. Then R′ N $= dt$. Whence $v = \frac{dx}{dt} = \frac{RN}{RN'} =$ co-tangent of inclination of the curve at the point R to the axis of x.

Therefore $\frac{dt}{dx} =$ tangent of inclination of the curve to the axis of $x = \frac{1}{v} = \frac{1}{\sqrt{2gx}} = \frac{\frac{1}{\sqrt{2g}}}{\sqrt{x}}$.

But this again is the property of a parabola, such that the distance from the focus to the apex $= a = \frac{1}{2g}$, so that the equation is

$$t^2 = \frac{2x}{g},$$

or $x = \frac{1}{2} gt^2$, which gives us the space fallen in the time t.

Again, let A B C be an inclined plane with height B C $= h$ and angle B A C $= \theta$, and let A B $= s$, and v be the final velocity at A along the plane, and t the time of descent from B to A. Then the acceleration of gravity down the plane $= g \sin \theta$, and $v = g \sin \theta \,.\, t$; but $s = \frac{1}{2}\ g't^2$

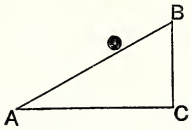
where g' is the acceleration down to the plane, and t the time of descent.

$$\text{Whence } \frac{h}{\sin\theta} = \frac{1}{2}\, g \sin\theta \,.\, t^2.$$

$$\therefore t = \sqrt{\frac{2h}{g \sin^2\theta}}$$

and $v = g \sin\theta\, t = \sqrt{2hg}$.

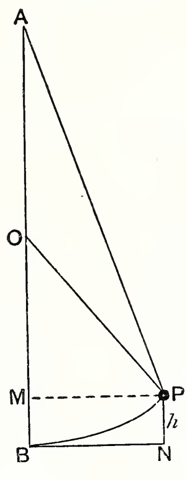
FIG. 13.



From the result it follows that the velocity of a particle falling from rest down a smooth curve of any kind under the action of gravity always $= \sqrt{2gh}$. For during each increment of resolved vertical fall dh, it always obtains a definite proportional increase of velocity.

This enables us to calculate the velocity of a

FIG. 14.



particle down a small arc of a circle of radius $= a$, to the lowest point of the arc. For if the particle fall from P to B, the velocity at B $= \sqrt{2gh}$, but $h =$ M B, whence

$$\frac{h}{BP} = \frac{BP}{AB}$$

$$\text{or } PB^2 \doteq 2ah.$$

Whence it follows that the velocity at B of the particle that slides down the arc from

$$P \text{ to } B = \sqrt{2g}.\ \frac{PB}{\sqrt{AB}}$$

$$= \sqrt{2g}\ \frac{PB}{\sqrt{2a}}$$

$$= \sqrt{\frac{g}{a}}\ PB,$$

and, therefore, is always proportional to the chord P B.

Suppose the particle slid, not down the arc P B, but down the chord B P, then from what has gone before, if t is the time of descent from P to B,

$$t = \frac{1}{\sin\theta}\sqrt{\frac{2h}{g}} \text{ where } PBN = \theta.$$

$$\text{but } \frac{1}{\sin\theta} = \frac{BP}{h} = \frac{\sqrt{2ah}}{h} = \sqrt{\frac{2a}{h}}$$

$$\text{and therefore } t = \sqrt{\frac{2a}{h} \times \frac{2h}{g}} = 2\sqrt{\frac{a}{g}},$$

and hence the time of fall down any chord in a circle to the lowest point of the circle is always the same, and for very small arcs, the arc and the chord are very nearly the same.

By the use of the differential and integral calculus the above operations become much simpler. For if $f = g$ (a constant),

Then by the third general equation of motion on a curve given above, $vdv = gdx$

$$\text{whence by integrating both sides } \frac{1}{2} v^2 = gx,$$

$$\text{or } v = \sqrt{2gx}.$$

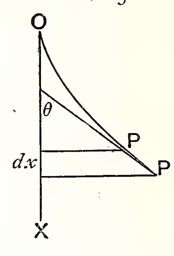
$$\text{but by (1) } \frac{dt}{dx} = \frac{1}{v} = \frac{1}{\sqrt{2gx}}$$

$$\text{whence } t = \int \frac{1}{\sqrt{2gx}} = \sqrt{\frac{2x}{g}}$$

$$\text{and } x = \frac{1}{2} gt^2.$$

If a body be moving down a curve under the

FIG. 15.



action of gravity, then the acceleration down the curve is $g \cos\theta$, whence

$$vdv = g \cos\theta\, ds, \text{ but } dx = ds \cos\theta,$$

$$\therefore vdv = gdx,$$

whence by integration

$$v = \sqrt{2gh}$$

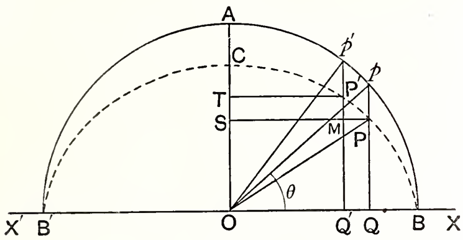
when v is the velocity along the curve and h is taken from the point from which the particle commenced to fall.

Let us now take another law for the value of the acceleration f, and suppose that the force acting on the particle is an attraction towards a point such that the force always varies as

the distance of the attracted particle from the point.

Let O be the point, and X X′ a line, and B be any position of the particle when at rest. Suppose that the strength of the centripetal or attractive force at O is such that when at a distance a, the particle is attracted by a force

FIG. 16.



which produces in it an acceleration $= a\,F$. Then, when the particle is at B, distant b from O, the acceleration would $= b\,F$, and when at any other point distant x from O, it would be $= F\,x$, and generally when at standard unit distance from O, the acceleration would be F.

If the particle when at rest at B is suddenly released, it will, of course, begin to move towards O with a velocity which will increase as it moves. When, however, it has passed O, the centripetal force, instead of augmenting its velocity, will retard it, so that it will again come to rest on the other side of O, and will continue to oscillate backwards and forwards on each side of O. This is, in fact, the motion of a ball fixed at one end of an elastic rod with the other end of the rod fixed in a vice. We shall now investigate its motion.

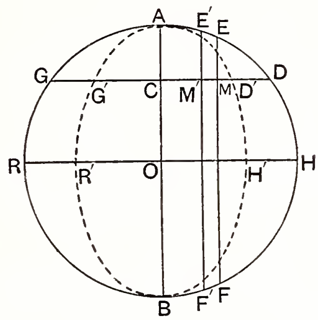
By the general equation (3) of motion given above we have $v\,dv = f\,dx = F\,x\,d\,x$. From points in X X′ draw a series of ordinates Q P, Q′ P′, so that by its length each represents the velocity of the particle resolved along X X′ at the point from which the line is drawn. Thus the line O C represents the velocity of the particle when it is moving through the point O along the line X X′. When the point is at B its velocity is Zero, and the ordinate is, therefore, $= o$. Of course, we may take vertical and horizontal scales for our diagram of any size we please so long as we remember what the scales are. These points P P′ will then form a curve B P P′ C.

Let P P′ be two points on the curve, and let Q Q′, the feet of the perpendiculars, be distant apart, Q Q′ $= dx$. Then taking the point O as the origin, P′ M respresents dv, and P′ Q $= v$, P S $= x$, and P M $= dx$. Whence from the equation (3) above given, we have

$$P'Q' \times P'M = F \times PS \times PM$$
$$= PS\sqrt{F} \quad \times PM\sqrt{F}.$$

This shows us that the curve B P P′ is an ellipse with centre at O, of which, if a semi-axis O B $= b$, then the other semi-axis is $b\sqrt{F}$, represented by the line O C and hence equal to the velocity along X X′ of the particle when at O.

FIG. 17.



For an ellipse is a circle turned round through an angle and seen in projection. Whence it follows that a point D′ on the elllipse always corresponds to D on the circle in such a manner that the ratio C D′ : C D depends on the angle through which the circle is turned, and is always constant. Let this ratio be called e. But it is a property of straight lines drawn at right angles to one another in a circle that E M × M F = D M × M G, whence if the circle be twisted round on its axis A B (Fig. 16) so as to appear an ellipse, then since D′ M′ $= e.$ D M and M′ G′ $= e.$ M G by substitution, D′ M′ × M′ G′ = e E M × M F, and the semi axis of the ellipse = O H′ $= e.$ O H.

Turning again to Fig. 16, if a circle be drawn with B B′ as diameter, then p Q the ordinate of the circle at the point $p = PQ\sqrt{F} = v\sqrt{F}$, and if we put the angle $p\,o\,B = \theta$, and the angle $p\,o\,p'$, be the small angle swept out as the particle moves from Q to Q′ and the corresponding points move from P to P′ and p to p', then we shall have

$$dx = PM = pp' \sin\theta = op \sin\theta\, d\theta = b \sin\theta\, d\theta,$$

and $pQ = b\sin\theta$, and $PQ = \sqrt{F}\ \ pQ$

$$= \sqrt{F}\,b \sin\theta,$$

whence the velocity of the particle along X X′ at the point Q $= PQ = b\sqrt{F}\sin\theta$.

Now going back to the general equation (1) of motion we have by substitution—

$$dt = \frac{dx}{v} = \frac{b \sin\theta \, d\theta}{b\sqrt{F}\sin\theta} = \frac{d\theta.}{\sqrt{F}}$$

This then shows us that the time in which any small part of the path of the point P along the ellipse P P′ is traversed, is always proportional to the angle swept out by the corresponding motion on the circle from p to p', that is to say that the motion of p is uniform as compared with time, and therefore that as the particle moves along the path, X X′, the corresponding point on the constructed circle moves uniformly round that circle. Whence then the particle will move from B to B′ in the time that the point p takes to move uniformly round half a circle. But the velocity of the point p, when it is at A, is equal to the velocity of the particle along X X′ when it is at O, and this, as we saw

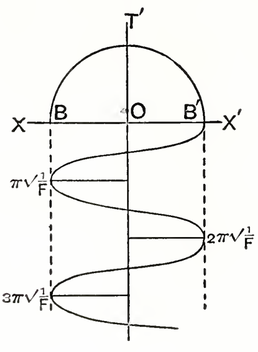
$$= b\sqrt{F}\ \sin\frac{\pi}{2} = b\sqrt{F}$$

Whence then, since the circumference of the semi-circle, B A B $= \pi\, b$, the time taken to go round it at a velocity $b\sqrt{F}$

$$= \frac{\pi b}{b\sqrt{F}} = \frac{\pi}{\sqrt{F}.}$$

And this then is also the time of passage of the particle along X X′ from B to B′. This time is independent of b, that is to say, independent of the distance of the point, on X X′, at which the particle starts from rest, and solely dependent on F, that is, on the force by which when at an unit distance, it is attracted to the centre, O, whence the oscillations of the particle will be isochronous.

FIG. 18.



If we desire to draw a curve such that its ordinates shall represent the times of passage from the points B B′ towards o, we have

$dt = \dfrac{d\theta}{\sqrt{F}}$, and, therefore, since the increments of time and of the angle p O B are equal, t (the time taken to travel from B to a point Q on X X′) $= \dfrac{\theta}{\sqrt{F}}$ where θ is the angle p O Q.

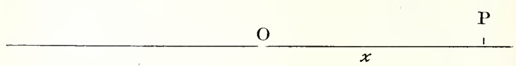
$$\text{Now } \cos\theta = \frac{x}{b}$$

$$\text{whence } \theta = \cos^{-1}\frac{x}{b}$$

$$\text{and } t = \frac{1}{\sqrt{F}}\cos^{-1}\frac{x}{b}$$

The form of this equation shows that when $x = b$; that is, when the particle is at B; that t has a series of values, viz., o; or $2\pi\sqrt{\frac{1}{F}}$, or $4\pi\sqrt{\frac{1}{F}}$; and so on; and that when $x = -b$, that is, when the particle is at B′, then $t = \pi\sqrt{\frac{1}{F}}$, or $3\pi\sqrt{\frac{1}{F}}$, and so on. It also shows that x can never have a greater value than b, for an angle, whose cosine is greater than unity, is impossible. Again, when $x = o$, $T = \frac{\pi}{2}\sqrt{\frac{1}{F}}$. From this we conclude that the curve has the form of the line shown in the figure, where O X and O T′ are the axes of x and t respectively. This is called the curve of cosines, for the abscissa is always proportional to the cosine of an angle proportionate to the ordinate.

The equations given above may be obtained, of course, more simply by the end of the differential and integral calculus. For if P be a



particle subjected to an attraction from O, which varies as x, our equations of motion become

$v dv = f dx = F x dx.$

whence $v^2 = F\,(b^2 - x^2)$ by integration between the limits of b and x,

hence $dt = \dfrac{dx}{v} = \dfrac{dx}{\sqrt{F}\sqrt{b^2 - x^2}}$, whence by integration $t = \sqrt{\dfrac{1}{F}}\cos^{-1}\dfrac{x}{b}$

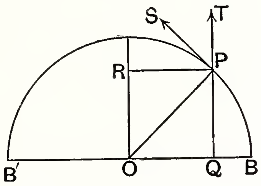
This is the equation to the curve of cosines. Between the limits of O and b we have as before

$T = \dfrac{1}{2}\dfrac{\pi}{\sqrt{F}}$ for the time of oscillation.

It is of interest to inquire what would happen if just as the particle were at B, and about to move towards O, a blow were given it at right angles to the line X X′. Suppose that by such a blow a velocity $=$ V were imparted to it. Then, while its motion along X X′ would remain the same as before, it would also have a motion at right angles to X X′. But this

motion resolved along T O being due partly to an impressed velocity, and partly to an attraction towards O, would be similar to the motion along X X′. In fact, we should have to consider the particle as subject to two sets of accelerations, one along X X′, the other perpendicular to it, and at any point P the particle

FIG. 19.



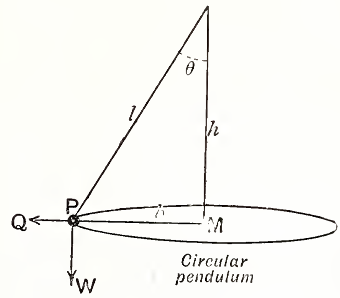
would be urged in a direction P R with a velocity equal to P Q, and in a direction P T with a velocity proportional to OQ. As a result it would, of course, move in the resultant direction P S, and would in its path describe a curve the tangent of whose inclination to the axis of $X = \mu$ Cot P O Q, where μ depended on the velocity imparted by the blow at B. This curve is an ellipse, except when $\mu = 1$, in which case it would be a circle. The time of describing the curve would be the same as the journey straight from B to B′ and therefore $= \frac{\pi}{\sqrt{F}}$. In fact, so long as the acceleration towards O remained unchanged the particle would take a uniform time in its path totally independent of the sign or shape of the ellipse in which it travelled.

If the body be moving uniformly in a circle round O under the influence of the centripetal force varying as the distance, and with a velocity in its circular path equal to V, then the acceleration ϕ inwards towards O would at every point of its path be the same, and would therefore equal the acceleration towards O when the body was at B. This we saw was b F, in fact it follows at once from the law of acceleration. Therefore $\phi = b$ F. The velocity would also be uniform and equal to the velocity at C, which is equal to the velocity at O of a body flying from B to O and equals as we saw $b\sqrt{F}$. Whence then by uniting these equations we have $\phi = \frac{V^2}{b}$.

This important result gives us the outward or centrifugal acceleration of a body flying in any curve at any instant when the velocity in the curve and its instantaneous radius of motion are known. The centrifugal force is, of course, $m\frac{V^2}{b}$ where m is the mass.

This enables us to deduce the laws of the circular pendulum. For if a body, tied to a string, l, be revolving round in a circle, under the action of gravity, three forces are at any

FIG. 20.



time in equilibrium—the pull on the string; the weight, w; and the outward centrifugal force, Q. Therefore

$$\frac{Q}{W} = \frac{PM}{h} = \frac{b}{h}$$

and as the accelerations are proportional to the forces, f the acceleration along P M $= g\frac{b}{h}$

Whence by the previous proposition,

$$f = g\frac{b}{h} = \frac{V^2}{b}, \text{ and } V = b\sqrt{\frac{g}{h}}$$

And therefore the time of revolution in the circle is equal to the circumference of the circle divided by the velocity, that is to say,

$$\frac{2\pi b}{V} = \frac{2\pi b}{b\sqrt{\frac{g}{h}}} = 2\pi\sqrt{\frac{h}{g}}$$

So that the time is dependent merely on the height of the point of suspension above the plane in which the particle is rotating; and remains constant so long as this is unchanged, and the velocity necessary to maintain the particle in this position $= \sqrt{\frac{g}{h}} \times b$; b, being the distance of the bob from the vertical, and h, the vertical distance of the bob below its point of suspension.

It will be shown hereafter that this is also the time of swing of a pendulum of length h, provided the arc be small.

As has been mentioned before, it is a property of springs that when pulled aside, the restitutional force is always proportional to the deflection so long as they are so little distorted by the deflection that the shape remains the same, or nearly the same.

Whence then it follows that the above investigation will serve for all cases of elastic springs or forces attached to or acting on massive bodies.

The motion takes place whenever a heavy

body attached to a spring of any sort is displaced and let go with or without a push. Thus, for example, if the centre of an elastic string, such as a piano string, were plucked aside and let go, its centre or belly would describe an ellipse, in which the motion would be as above described. The shape of the ellipse would depend on the nature of the impulse. It might be very narrow, and almost a mere line, or it might be nearly or quite a circle. But the law of vibration is always the same, the circular motion as we have seen looked at sideways appears linear. The time of vibration (on which the pitch of the musical note produced depends) would remain constant, depending on the acceleration produced towards the position of rest by the elasticity of the spring. The amplitude of the vibrations would, however, diminish by reason of the friction of the air, and the communication to the air of the motion of the string. As the amplitude diminished, the strength of the impulses given to the air would diminish, and the loudness of the sound would decrease and die away, but the periodicity of the impulses would remain unchanged, and therefore the pitch would remain always the same. This property of the motion has caused it to be termed "harmonic." And, inasmuch as the vibrations of waves of light, electricity, air, and, in fact, all vibrations depending on elasticity, or elastic bodies, are harmonic, we can easily see why light as it fades away still retains the same colour, for the colour depends on the vibrations of a medium whose elasticity remains constant.

The theory of harmonic vibrations is the foundation of the theory of the pendulum and of the balance wheel, and unlocks the largest part of the problems of physical motions.

(*To be continued.*)

ERRATA.—In the appendix to the first part, please read on page 933, first column, 1 centimetre = ·39370113 inches. In second column, for —256 C., read — 273° C. And under the density column, opposite invar, please read, 8·1, which figure has been supplied through the kindness of M. Guillaume, the distinguished Assistant Director of the International Bureau of Weights and Measures, at Paris, who also observes that the figure of delatation for steel is put rather high, and that though it is correct for soft steel, yet for hard steel the co-efficient descends even to ·0000105. The delatation figure of iron he considers as larger than that of steel. There is, in fact, no doubt that the delatation figures vary considerably, and that the co-efficient ought to be measured in every case, for a pendulum of precision.

CENTRAL SCHOOL OF ARTS AND CRAFTS.

The Central School of Arts and Crafts was established by the Technical Education Board in 1896, in temporary premises in 316, Regent-street, W., and Little Portland-street. By 1898 the number of students had so increased that the capacity of the temporary premises was fully taxed and there was no room for any extension of the work. To meet the demand, additional premises were rented in the neighbourhood. In the meantime the search for more suitable premises continued, and ultimately the Council resolved to appropriate the present site in Southampton-row.

Mr. W. E. Riley, F.R.I.B.A., has been the superintending architect of the building and the work has been carried out from his designs and under his direction.

The site, which is irregular in shape, has a frontage to Southampton-row of 106 feet 9 inches, and to Theobald's-road and Paxton-street of 106 feet 6 inches, and it has been necessary to cover practically the whole ground to give the required accommodation. The building contains a basement and six other storeys, which together give a floor space of about 74,000 square feet; it contains in all 70 rooms, viz., 42 class-rooms or workshops, a large central hall, common rooms, administrative offices and staff rooms.

In the basement are the rooms for the heavy work, comprising leadwork, stonework, ironwork, metal-casting, &c., the principal lavatory for the students, and the boilers for the heating system, which is common to this building and to the training college.

On the ground floor are the administrative offices, staff rooms, common rooms for the students, class rooms for architecture and wood-carving, and the central hall, which is lighted by a dome.

A lecture theatre to accommodate 300 is situated on the corresponding floor in the training college; it is directly accessible from the school, and is intended to be used jointly by both departments.

On the first floor are the class rooms and workshops for goldsmiths' and silversmiths' work and allied crafts, including chasing and repoussé, modelling, engraving and die-sinking.

On the second floor are the class rooms for the arts and crafts in connection with book production, namely, illuminating, typography, lithography, wood engraving and bookbinding.

On the third floor are the rooms devoted to the arts and crafts connected with cabinet work and furniture, namely, drawing and design, cabinet making, polishing and upholstery.

On the fourth and fifth floors are the studios, class rooms and workshops, which require special consideration in their lighting, viz., those for life drawing, painting, modelling, stained glass, decorative plaster, embroidery, and weaving.

Accommodation is provided for about 900 students at one time. Special arrangements have been made for adequate means of escape in case of fire, and the

general construction of the building is fire-resisting throughout.

The general height of the class rooms, from floor to ceiling, is 13 feet; that of the central hall is 23 feet to the underside of the dome. The height of the building from the street to the top of the cornice is 75 feet 6 inches, and 87 feet 6 inches to the ridge of the roof.

The façades to the streets are of Cornish granite from the Colcerrow quarries and Portland stone. The entrance and central hall are paved with Hopton wood stone.

The building has been designed, conjointly with the adjoining training college, in a plain and substantial manner with the intention of giving expression to the purposes for which it is used.

The work of erecting the building has been carried out by the Works Committee of the Council under the immediate direction of Mr. G. W. Humphreys, the Council's manager of works.

The work in connection with the heating and electrical equipment has been carried out under the supervision of Mr. Maurice Fitzmaurice, C.M.G., the Council's chief engineer.

The electrical energy for both lighting and power purposes in this building is supplied by means of two distinct services, and in the event of failure of either of these, an automatic switch will bring the other into use. Inverted arc lamps have been largely installed and incandescent lamps, where used, are of metallic filament type. Electrical energy also drives the two large exhaust fans which deal with the ventilation of the building and a goods lift for serving each floor. Fire alarms have been fitted throughout the building and a system of electric clocks is provided for the principal rooms. Provision is also made in some of the class-rooms for the use of electrical power for the purpose of driving mechanical tools, heating small furnaces, &c.

Special consideration has been given to heating and ventilation, the heating apparatus consisting of radiators heated by low pressure steam on the vacuum system, fresh air being taken in through the outer walls and warmed before entering the rooms. Each radiator is separately controlled. The steam is raised by two large multi-tubular boilers, of the Cornish type, placed in the basement.

The equipment of the building, other than permanent fittings, has been selected by Mr. R. Blair, M.A., the Council's Executive Officer.

The work of the school in assisting students engaged in the typical London artistic crafts will in the future, as in the past, mainly be carried on in evening classes. During the day, however, classes have for some time existed for the benefit of students who were able to attend. These will now be further developed, and, in addition, the classes for many years carried on at Queen-square under the title of the Royal Female School of Art will be incorporated with the Central School, while the Day Technical School for Boys preparatory to the Silversmiths' and allied trades, started two years ago, will be extended, and similar day schools may probably be formed in connection with other departments.

The school is under the direction of Professor W. R. Lethaby. Prospectus and all particulars can be had on application to the Secretary, London County Council Central School of Arts and Crafts, Southampton-row, W.C.

THE UTILISATION OF PEAT.*

The much-discussed subject of the utilisation of peat has during the last few years been revived, owing to developments in gas producers and in gas engines, and at the moment it is of considerable interest in Ireland in connection with the Bill which has been promoted in Parliament to obtain powers to produce gas from peat, to use this gas for making electricity by means of gas engines and dynamos, and to distribute electric power to works which will probably be established in the immediate neighbourhood of the power station and throughout a certain prescribed district. It is proposed to put the power station alongside the Grand Canal, not far from Robertstown, about twenty-five miles from Dublin.

Previous attemtps to utilise peat for power failed because they were based on drying the peat, so as to contain no more than 25 per cent. of water, and in some cases the expense of "briquetting" was incurred; the peat was then transported to the place where power was required and burnt in boilers fitted with specially designed furnaces. Such peat could not compete with coal; moreover the valuable by-products were not recovered.

In the proposed scheme the peat will only be partially dried—that is, will still contain 60 per cent. of water; it will be used on the spot to make gas, so as get the benefit of the great thermal efficiency of gas engines and to save the cost of carriage. The by-products will be recovered, the profit on which will at least cover the cost of getting and drying the peat. It will be possible to supply power to works in the immediate neighbourhood of the power station as cheaply as can be done from water-power. Many of those industries which are dependent upon cheap power will undoubtedly be attracted.

Great progress has been made in Germany in the utilisation of peat. Although no complete electric power undertaking is at present working on the above lines, all the various links in the chain are separately and successfully in operation; many of these links have been "made in Germany," why should not the complete chain be put together in Ireland?

There are several methods of getting and drying peat. Apparently, the most suitable, when it is desired to obtain peat nearly all the year round, is

* Abstract of a paper read before the Mechanical Section of the British Association, Dublin, 1908, by Capt. H. Riall Sankey, R.E. (ret.), M.Inst.C.E.

to dig with a grab, and pass the peat through a Dornberg press. The peat then rapidly dries to 60 per cent., except in very wet weather in the winter, and to tide over this period a reserve of peat must be accumulated.

The producers used for making gas from peat are similar to those used with bituminous coal, but they are larger in dimensions for the same power. The gas issuing from the producers passes through the recovery plant, thence to the gas engines. The gas in passing through the recovery plant is cleaned in a very perfect manner, and therefore troubles due to tar and dust are entirely obviated.

Sulphate of ammonia is the principal product. The amount obtained depends upon the percentage of nitrogen in the peat. The proposed power station at Robertstown will be capable of making 3,000 tons of sulphate per annum.

The other important by-products are acetate of lime, methyl alcohol, and tar containing paraffin wax and oils. An excellent waggon grease can be made from the tar, the output of which at Robertstown ought to be about 2,000 barrels per annum. The monetary value of these by-products will be about equal to that of the sulphate of ammonia.

An excellent charcoal can be made from peat, instead of gas, together with the by-products enumerated above, and the process has been in operation near Oldenberg for over ten years. The most up-to-date factory, however, is at Beuerberg, near Munich, and it has been at work for three years. The charcoal obtained from peat is of excellent quality, and can be used to advantage to replace wood charcoal. It is used in large quantities in Germany in connection with the manufacture of steel.

FRENCH MARKET GARDENING.

Intensive cultivation of vegetables is carried on to an extent and to a degree of perfection in the immediate vicinity of Paris that has not been attained elsewhere. Not only are vegetables cheaper and better in Paris than in most European cities, but vegetables grown in the immediate vicinity of the city are sent to the United Kingdom, Germany, Austria, Belgium, and even to Russia. The English trade is especially important, and large quantities of vegetables, sold in London during the winter and the early spring, are grown under glass in the neighbourhood of Paris. These results are due to a system of intensive gardening that makes it possible for a family to live comfortably on the produce of from one and a half to two acres, by the thrift and skill of the French gardeners. According to the American Vice-Consul in Paris, the French method of treating the soil consists in a continual mixing and compounding of the top soil, the slow and laborious system of trenching employed by English gardeners not being adopted. With new ground the French gardener begins by digging out the top soil, which he mixes and re-mixes with manure, and a thin surface of this soil is laid on the best manure. The heat necessary for the growth of vegetables in winter and early spring is derived from the fermentation of manure. Each gardener maintains a manure pile, which is built up during the summer, the manure being pressed to retard fermentation, which is only partly effected in the pile as the manure becomes dry. The dried manure from the pile is mixed with a smaller quantity of fresh manure when used in the garden. The fresh manure re-starts the decomposition of the dried material, which produces a steady warmth whose intensity can be regulated by the quantity and amount of manure used, whereas fresh manure, if used in quantities, would produce an intense heat that would soon give out. The vegetables grown in the winter and early spring are grown under glass bell jars, or glass hinge frames. That the glass is not the whole secret is shown by the amount of lettuce and other green stuff grown in the early spring between the bell jars. A plentiful supply of water is essential to such a system of cultivation, and the gardens are provided with motors which pump the necessary water so that all parts of the garden can be sprayed by hose connected with underground pipes. Within a radius of six miles of the fortifications of Paris there are twelve hundred *jardins maraîchères*, or truck gardens, under extensive cultivation, having an average area of from one acre and a half to two acres each. By far the greater part of these gardens are situated within a mile of the city and a considerable number are within the fortifications. Especially to the south-east are to be seen numbers of gardens from which large quantities of vegetables, particularly early lettuce, are sent to the markets of Paris, London, and Cologne. Land is necessarily very dear, and the price of a two acre garden with house varies between £2,000 and £2,400, which lets from £80 to £100 per annum. The cost of equipment of such a garden, including petroleum motor necessary for pumping water, glass bells, frames, &c., averages about £1,000. The cost of equipment is borne by the gardener who often borrows the necessary capital. The Secretary of the Syndicate of Market Gardeners, a practical gardener of long experience, estimates the average yearly savings of the gardeners after deducting their living and other expenses, and interest on their investment, at about £100. Remarkable profits are sometimes realised by early or fancy crops, an acre of land sometimes producing £1,200 per annum, but such results are exceptional and require considerable skill and increased outlay. The average gardener is satisfied if he can make from £300 to £320 from an acre, and a net income of from £160 to £200. Many of the gardeners own the land they cultivate, and in some instances fortunes have been made by the rapid increase in the value of land. A market garden situated within a mile of Paris, which was personally examined by the Vice-Consul, produced annually some £640 worth of vegetables, on

an area of about two acres. The rent paid for this was £80, and the tenant, who worked it, could count upon a net annual income of £160 and the use of a simple but comfortable house. The heaviest items of expense were the wages of four field hands, the purchase of stable manure, the maintenance of a horse and cart for carrying produce to market, and the maintenance and repair of glass, &c. The workmen were boarded and paid something over two shillings per day, the rate of remuneration varying according to season. When labourers are not boarded they are paid from about four shillings to six shillings per day. The garden showed every evidence of thrift and industry, and when visited there was not a square foot of unutilised space, and this was said to be the case during the entire year. In some places three kinds of vegetables had been sown simultaneously, the earliest vegetable being removed before the second was ready for development. The Paris gardeners keep their land productive by a quick rotation of crops the entire year, but they make their profits in the winter and spring. In the summer and autumn prices are lowered by the competition of the large truck gardens, situated on cheaper land, but within easy reach of Paris, and the export trade ceases to be profitable. Certain vegetables bring reasonable profits during the summer — melons, for instance, being sent to cities south of Paris. As a rule the gardeners are satisfied if they can make a living in the summer, and they make their profits with the vegetables grown before their natural season. It is calculated that 100,000,000 heads of lettuce are produced annually in the *jardins maraîchères* of Paris, the greater part of which are forwarded to London and Cologne during the winter and spring. The existence of the *jardins maraîchères* in close proximity to the city is due to the facilities for procuring suitable manure at reasonable prices, and to the nearness of a great market. The produce sent to Paris is forwarded to the central market. The rapid development of railway facilities has placed Paris in easy communication with the south of France and Algiers, where vegetables can be grown in the open fields the greater part of the year, and it is a striking proof of the value of the system of cultivation practised by the Paris gardeners, that in spite of this competition and the dearness of the land, the production of the *jardins maraîchères* is increasing. The growth of competition and higher prices for manure, wages, &c., have affected the production of the gardens, and certain vegetables can no longer be grown profitably. Only a fancy variety of tomato for instance, the cultivation of which requires special pains and skill, and which finds a very limited market on account of its price, brings a fair remuneration. It is also likely that early asparagus, which has been an important product, will eventually be produced only in the south. It is not considered probable, however, that outside competition can affect the demand for the early lettuce and greens of the market gardens. The Syndicate of Market Gardeners, one of whose principal objects is to further the export trade, has been devoting attention to the feasibility of exporting early vegetables to New York, and only the difficulty experienced in obtaining a satisfactory arrangement for the cold storage of its products on the transatlantic liners, and the fact that the growing demand in England offers a sure and profitable market for more vegetables than the growers can supply, has postponed the execution of the project.

POPULATION IN IRELAND.

The forty-fourth annual report of the Registrar-General for Ireland shows that notwithstanding the efforts of Parliament to lessen the desire to emigrate, the absolute decrease in the population continues. In 1907 the excess of births over deaths was 24,408, but the loss by emigration amounted to 39,082, so that there was a decrease of 14,674 in the population during the year. In 1906 the emigration only amounted to 35,344, and taking the years 1897-1906, the average is below that of last year. The population of Ireland has now fallen to 4,377,964, the percentage of emigrants last year being 8·9. The marriages registered in 1907 were slightly below those of the preceding year—5·14 per 1,000 as against 5·17. A crude test of the progress of elementary education is afforded by the signatures of the contracting persons as seen in the marriage registers or certificates. In 1907, 92·0 per cent. of the husbands, and 94·0 per cent. of the wives wrote their names, and the remainder signed by marks, as against 84·8 per cent. of the husbands and 86·7 per cent. of the wives in 1897. The births registered during 1907 amounted to 23·2 per 1,000, which is equal to the average rate per 1,000 for the years 1897-1906. It may be noted that the illegitimacy rate continues to fall. The number of illegitimate children born in Ireland in 1907 was 2,564, or 2·5 per cent. The highest percentage was in Ulster, 3·3 per cent., the lowest in Connaught, only 0·6 per cent. These results bear favourable comparison with the returns for most other countries. The death-rate in 1907 was 0·7 above that of 1906, but 0·2 under the average of the preceding ten years. There was a somewhat serious increase in the deaths from pneumonia; also an increase in alcoholic mortality.

PRODUCER GAS.*

The author's first paper on this subject was read at the York Meeting in 1881, and after twenty-seven years he reviewed briefly the progress since made. In large furnace-work he traced the developments and improvements in the system introduced by the brothers

* Abstract of a paper read before the Mechanical Section of the British Association at Dublin, 1908 by J. Emerson Dowson, M.Inst.C.E.

Siemens. Its success has been great, and has been due chiefly to heating the air for combustion by the waste products. Dr. Mond's recovery of ammonium sulphate, which reduces the cost of fuel, is also mentioned. For smaller heating work, where jets of gas are required, it is essential that the gas should be clean, of good quality, and of uniform pressure. This is especially necessary where the gas must be burnt with air at pressure, or for blow-pipes, &c. Producer gas is now used for the following as well as many other purposes:—Cooking and baking in hospitals and asylums, japanning and enamelling, typefounding, varnish making, melting in crucibles, cutting and finishing glass, heating tailors' irons in clothing factories, and laundry irons, calenders, &c., gassing silk and cotton yarns, singeing textile fabrics, soldering biscuit and condensed-milk tins, &c., annealing, hardening and tempering, boiling sugar, roasting coffee, cocoa, and other food products in factories. Notwithstanding this, the author considers that, in proportion to the immense amount of heating required in the various industries throughout the Kingdom, more progress would have been made if manufacturers aud others knew more about the subject technically. Often they do not seem to understand the treatment of gas, or what can be done with it. Undoubtedly the greatest development in the use of producer gas has been with gas engines. A gas engine was worked for the first time with producer gas in 1879, in a plant devised by the author. The calorific power of producer gas is the same now as then, but less gas is now consumed per h.p., owing to improvements made in the engines. The meaning of *pressure* and *suction* gas was described. In 1862, Dr. Jacques Arbos, of Barcelona, patented a gas producer worked by the suction of an engine, but the first to deal with this in a practical was M. Léon Bénier, of Paris (1891). Various modifications and improvements have since been made, and the suction plant is extensively used. The chemical reactions on which pressure and suction gases depend are identical, but the calorific power of pressure gas made with a jet of superheated steam is usually considerably higher than that of suction gas. For heating purposes in small burners, or in blow-pipes, pressure gas is better, and an engine worked by suction gas developes a rather lower maximum power than with pressure gas. In considering the two types of plant for engine work, the general conclusions are:—A suction plant costs less, and occupies less ground space, but the gas made in it is not so strong as in the older form of pressure plant, and in some cases this is important. The fuel consumption per h.p.-hour and the labour required are the same in both types of plant, provided the steam required for the pressure gas is raised without an independent boiler. The consumption of water is the same in both types. Where there are several engines to serve, the gas piping is simplified and its cost reduced when the gas is taken from a small gasholder, instead of from several suction plants. In some cases the pressure type is better than the suction, in others suction is better than pressure. From the economical point of view, where producer gas is used for heating work instead of ordinary town gas, there is usually a saving of 50 to 60 per cent. With engines, the consumption of anthracite is guaranteed not to exceed 1 lb. per b.h.p.-hour (under full or three-quarter loads) in both types of plant. Gas coke is also used, but its consumption is a little higher. For large furnace work non-caking bituminous coal is almost invariably used, and in some cases this kind of coal is also used for engine work.

THE FORMOSA TEA INDUSTRY.

The exports of tea from Formosa during 1906 amounted to 21,992,000 lbs., valued approximately at £700,000, of which the United States took 17,000,000 lbs., against 18,000,000 lbs. in 1905. In February, 1906, the Formosan local government changed the tea manufacturers' tax so as to make it payable by the exporters instead of by the manufacturers, as was formerly the case. This tax amounts to 5s. per picul ($133\frac{1}{3}$ lbs.). In addition to this tax there is also imposed by the Government an export tax of 3s. 4d. upon every $133\frac{1}{3}$ lbs. During 1906 the manufacturers' tax and the export have brought a sum of £70,000 to the reveue. A tea expert has been endeavouring to show the Chinese growers that the application of proper fertilisers to the cultivation of the plant will increase its productivity by at least 75 per cent., without in the least injuring the flavour of the tea. As a further step towards decreasing the cost of production, the utilisation of the inferior leaves, which at one time were almost a dead loss to the dealers, is recommended in the manufacture of "pouchongs" and black teas. This pouchong tea is an oolong, scented with the flowers of jasmine and gardenia, &c., and finds a market with the Chinese population in the Straits Settlements, the Philippines, Hawaii, and also in some parts of the United States, where the Chinese are in considerable numbers. In 1906, as much as 4,300,000 lbs. of pouchong were exported from Formosa, about one-half the quantity being the product of the island. It is now the intention of the authorities in Formosa to secure a market in Turkey and Russia for brick and black teas of Formosan production. In this manner it is hoped to utilise the tea dust, which at present finds no market. Efforts are being made to effect an organisation on the part of the growers and manufacturers, with the object in view of off-setting the brokers' monopoly of profits. The present system is so deeply rooted, involves such varying interests, and is so thoroughly Chinese, that it is not to be supposed that any substantial results towards effecting a change can be hoped for until conditions alter sufficiently to warrant such action on the part of the growers and manufacturers, or at least to make such action on their part a possibility.

ARTS AND CRAFTS.

National Competition.—The aspect of the annual exhibition of works gaining prizes in national competition has undergone a considerable change in recent years. The show used to consist entirely of drawings, paintings, designs, and modelling, but some years back an arrangement was made by which students were allowed to send up objects executed from their designs, and the practice of submitting executed specimens has become increasingly popular, until to-day a very large proportion of the awards given fall to students who send in not merely designs, but the work actually done from them.

It is, of course, very much to the good that students should enter executed work for competition, and not only drawings for such work. A design which is not practical may look very pretty on paper; the fact that, while it is intended for a cotton print it has somehow the air of being meant for a silk, may even militate in its favour if the examiners do not constantly remind themselves of the purpose which it is supposed to serve. Again, designs (at any rate those to be executed by any manufacturing process) simply cannot be carried out if they are not workmanlike, while, on the other hand, many an artist craftsman who can do really good work finds it strangely difficult to make a satisfactory drawing of what he wants to do. It is, or should be, therefore, to the interest alike of designers and craftsmen that executed work should be allowed and even encouraged at national competition—and it was most certainly a step in the right direction to permit it to be sent up. For all that, after paying careful attention to the awards of the past few years, it would be hard to say that the new arrangement has answered quite perfectly, however heartily it may be admitted that it has done a good deal of good. There seem to be two tendencies which it is hard to completely counteract in judging works carried out in such widely different materials as, for instance, table damask and wrought iron, or cotton and china.

It is difficult, in the first place, to separate the value of a man's design from the quality of the material with which he has to do. He has probably no choice whether he will design, say, for ordinary table ware or for the finest lustre pottery—and the beauty of his material, however real it may be, and however incumbent it may be upon him to develop it to the utmost, is, after all, no merit of his. And yet, in judging the finished work, it is hard for the examiners—artists themselves, and therefore susceptible to beauty of all kinds, not to be prejudiced in favour of the more beautiful material.

Again, the conditions of the competition make it impossible to insist upon the finished work being executed by the designer. There is no reason why, for example, a carpet design should be carried out by the man who plans it—and very little possibility of his doing so. In other cases, like jewellery, metalwork, or enamelling, where the designer may be but is not necessarily the executant, feeling of which he was quite innocent may be imported into his design by the person who carries it out—and in any case the design may, through no fault of its author, be ruined in the reproduction. Further, the designer for, say, a textile fabric very possibly cannot get his designs carried out for competition, while the stenciller has the remedy for any such trouble entirely in his own hands.

The difficulty of balancing all these different considerations is considerable, and it is surprising under the circumstances that there is not more inequality in the judging. Still every now and again one is struck by an award which seems in some measure to have been earned rather by the merits of the process of manufacture or of the material in which it is made, than by the artist—whilst from time to time good designs seem to rank rather low when not accompanied by the executed work.

There are always little fashions in the work done for national competition, and from time to time some fresh process or new development comes to the fore and takes an important place. This year there is, as usual, a large show of metalwork, jewellery, enamel, embroidery, and bookbinding. A very fair amount of satisfactory lettering and illumination is shown, and also some good poster designs and stained glass. One or two high awards are given for pottery; several silver medals are awarded for stencilled hangings, aud one for a very pleasing damask napkin. It seems a great pity that in such important branches of art industry as woven and printed cotton, printed velvet, woven silk, and carpets, nothing worthy of a higher prize than a bronze medal has been sent up, whilst the best wallpaper design only reaches the standard of a book prize.

A rather pleasing little new depature in the way of decorated vellum triptychs and caskets is to be noted this year. The work comes mainly from Armstrong College, Newcastle, and it is remarkable for its charming delicacy of colour and of handling generally. From Manchester and its neighbourhood come an interesting little group of designs for stencilled cotton fabrics. It seems a little odd, however, that from this particular part of the world we should get designs for stencilling rather than for printing.

The Retrospective Exhibition.—The Retrospective Exhibition of works which have gained gold and silver medals in National Competition between the years 1898 and 1907 is, of course, interesting from the point of view of design. It reveals in the earlier years that the examiners at least and probably, too, the cleverer students themselves, had the good sense not to be carried off their feet by the "art nouveau" movement which was so popular on the continent, and in some places is still dying so hard. The result is that the prize works practically do not show date at all: those which were executed at the beginning of the period do not look in the least old-fashioned and there is, on the whole, very little which can be accused of being "mannered." The only unsatisfactory point about an otherwise interesting and

really admirable show is that there is so little evidence of steady advance in design or of progress in any particular direction in the exhibits. It would seem as though the rather unsettled artistic conditions of the past ten years—the conflict between the old and the new, between tradition and originality—had arrested, for the time being, at all events, the development of design, which has moved rather restlessly from one point to another without, in the end, being any further that it was when it started. It is to be hoped that the next ten years will show more steadiness of aim, and therefore more real progress.

Decoration and Furniture in Italy.—It is interesting to notice the lines on which the Italian decorating and furnishing trades have been going since the Milan Exhibition of two years ago. Naturally, in Italy, as elsewhere, a good deal of work is being done frankly in imitation of the old styles, and some of the furniture, especially when it is upholstered with reproductions either of old embroidery, or of lacquered leather, is really very pleasing in its way. When we turn to the really modern work, we find that it takes its inspiration in the main from Germany and from France. The wallpapers most constantly in use, whether manufactured in France, England or Italy, are much in the manner of those fashionable in England. The stripe is still the commonest motif, but papers so schemed that there is a heading of ornament at the top of each cut length while the lower part of the wall is decorated simply with a small and perhaps insignificant star, sprig, or spot pattern, are very much in vogue. Papers which simulate some sort of textile fabric, silk, velvet, linen, or whatever it may be, seem to be, as usual, even more popular in Italy than they are at the present time in England. The ceiling paintings, which are always so prominent a feature of Italian decoration, very often show the influence of the Grasset school, as do some of the designs issued in those periodical publications which give coloured plates of decorations. Indeed, if it were not for the names of the Italian artists responsible for their design, one would often take them for the work of artists of some other nationality. It seems a little strange that, while so many countries are beginning to take a pride in their old traditional designs, Italy—proud as she is of her national unity—should be looking to other countries for her artistic motifs.

There is so much Austrian and German furniture in the country, that it is, perhaps, not to be wondered at that some of the Italian-made furniture should be built on lines which are more or less reminiscent of Austrian "bent wood." For the rest, the furniture being made on modern models is singularly quiet and dignified in its shapes, and there is little or no affectation of any kind about it. In Italy, as with us, there seems to be quite a fashion for inlaid furniture just now, and not only various different woods, but also mother-of-pearl is being used for this purpose with very good effect. Some of the inlay work is very large in scale, and very naturalistic in conception—whole suites of furniture being adorned with floral decoration in inlaid wood. This kind of ornament is not, perhaps, very beautiful in itself, but when executed in carefully chosen woods, it has a certain charm of colour which goes far towards covering a multitude of deficiencies in design.

GENERAL NOTES.

Life in Argentina.—Reporting on the trade and commerce of the consular district of Buenos Aires, Mr. Consul Ross (No. 4064, Annual Series) says that the district of the consulate includes not only the well-known province of Buenos Aires, which has an area of over 100,000 square miles, but also nine other provinces of a joint area of 370,000 square miles, and ten territories of an area of 555,000 square miles. All the provinces are connected by railway with Buenos Aires. The population of the whole district is sparse, and in much of the Andine country, and of the territories both north and south, the climatic or soil conditions will never admit of anything like a dense population. Much has been done in the north with the cultivation of sugar, cotton, and timber, breeding of cattle, and the mining of copper; in the west with the cultivation of vines, and in the south with the breeding of sheep. The southern territory is suitable for little else than cattle and sheep breeding, and a little agriculture; but in the north it might be possible to cultivate tropical and sub-tropical fruits and products, such as cotton, tobacco, and rubber plants.

British Commercial School at Mannheim.—British students who intend to put in a few terms at Heidelberg University may be interested to know that the first steps have been taken to found a commercial high school at Mannheim, to be run in connection with the University. Referring to the matter in his report on the trade of the Duchy (No. 4070, Annual Series) Mr. Consul Ladenburg says that the first term began on April 27th of the current year, the full course of study extending over two years. This commercial academy is the sixth of its kind in the German Empire, whilst Heidelberg, as is well known, is the oldest of its Universities. As the distance by train between Mannheim and Heidelberg is about a quarter of an hour, the trains running at intervals of barely thirty minutes, it has been comparatively easy to arrange the time of the new commercial school in such a manner as to give students in either place of education an oportunity of attending the more important lectures in the other as well. At the end of the second year a final examination takes place, successful candidates being granted a certificate, in virtue of which they receive the title of "Diplom-Kaufmann," namely certificated merchant, to distinguish them from those who have not had a similar scientific training.

Journal of the Royal Society of Arts

No. 2,915. VOL. LVI.

FRIDAY, OCTOBER 2, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

CANTOR LECTURES ON FUEL.

Professor Vivian Lewes's Cantor Lectures on "Fuel and its Future" have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John-street, Adelphi, London, W.C.

A full list of the Cantor Lectures, which have been published separately and are still on sale, can be obtained on application.

PRIZES FOR INDUSTRIAL DESIGN.

The Council of the Royal Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Committee of that fund in 1876, on condition of the interest thereof being spent in Prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damasks, Chintzes, &c., regulated by the principles laid down by Owen Jones."

Competitions, under the terms of this Trust, have been held annually since 1878.

The next award will be made in 1909, when six prizes are offered for competition, each prize to consist of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

The prizes will be awarded on the Report of the Examiners in the National Competition of the Board of Education. The designs must be submitted in the usual manner to the Board of Education, South Kensington, S.W., by the 1st of April, 1909. They must be marked "In competition for the Owen Jones Prizes, and must comply with the regulations of the Board of Education.

No candidate who has gained one of the above prizes can again take part in the competition.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

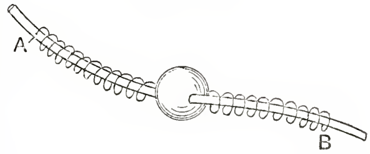
THE THEORY AND PRACTICE OF CLOCKMAKING.*

By Sir Henry Hardinge Cunynghame, K.C.B.

PART II.—(*continued*).

To return, however, to our vibrations along a line. If a massive bead is contrived so as to slide, without friction, along a rod, A B, and springs are attached to it so as always to bring it to rest in the centre; then because the force developed in a pressed spring is always proportional to the displacement, any

Fig. 21.



displacement of the bead, along the rod, would be productive of a restitutional force, drawing it back to the centre with a force proportional to the displacement. The motion, therefore, will be harmonic, and if the bead vibrates, the period of the vibrations will be dependent simply on the mass of the particle and the strength of the springs, and quite independent of the ampli-

* The Course consisted of Six Lectures, delivered Jan. 20, 27; Feb. 3, 10, 17, 24. In re-arranging the material for publication, the Lecturer has preferred to divide it into Four Parts.

tude of vibration. And if the mass m, and the restitutional force were such that, at a foot from the centre, there was produced a restitutional force of F poundals (*i.e.*, a restitutional force capable in one second of producing in a mass of 1 lb., an acceleration of F feet per second), then the time of vibration would be $\pi\sqrt{\frac{a}{\frac{F}{m}}}$ seconds.

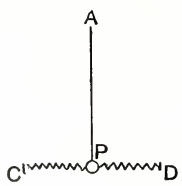
For instance, suppose we had a mass of 4 lbs., and that it was attached to a spring of such a size and make, that the weight of 4 lbs. extended the spring by 2 feet. Then it is clear that the spring would be of such a character that when stretched to an amount equal to 2 feet from the neutral position, its accelerative force would equal the attraction of gravity on a mass of 4 lbs., in other words, it would be 4 poundals, that is to say, would be a force that would cause in the 4 lbs., an acceleration of motion of 32 feet per second if it acted for one second.

In other words, F would $= 4 \times g = 4 \times 32 = 128$. Whence then, in the example $F = 128$, $a = 2$ feet, $m = 4$ lbs. And if t were the time of oscillation of the mass independently of any action of gravity, then

$$t = \pi\sqrt{\frac{2}{\frac{128}{4}}} = \cdot 79 \text{ seconds.}$$

It is easy to try this experimentally by making a frame say 10 feet high, by four feet wide. Suspend a ball in a frame from a short cord, and tie an elastic band to each side of the ball, and fasten them at C and D. Now

Fig. 22.



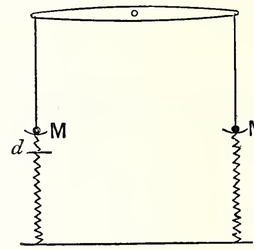
turn the frame on its side and observe how much the ball is deflected from its central position P. If M be the mass of the ball in pounds, and d the deflection from P (in feet) caused by its own weight. The time of vibration, when the frame is again put upright should be

$$T = \pi\sqrt{\frac{d \cdot M}{M \cdot g}} = \pi\sqrt{\frac{d}{g}}$$

which we shall presently see is the time of vibration of a pendulum of length d.

In practice, of course, the result is complicated by the fact that our theory requires one to suppose that the string A P is infinitely long, so that the oscillations of P shall be strictly horizontal. This is not the case. We can, however, arrange another contrivance that will obviate this difficulty. Divide the mass M into two masses, and put them into

Fig. 23.



the scales of a very light balance which is carefully adjusted, and so light as compared with the masses, that it may be treated as having no period of swing of its own. Attach a spring on each pan, and fasten it down below the pan. Now put a weight m in one pan and observe the amount d by which the pan descends. The accelerating force on the weight m is obviously the force necessary to stretch the combined springs through a distance d, and is hence equal to their accelerating force when stretched to a distance d. Gravity does not come into play here on the masses M, for they balance one another, but only on the mass m. Hence F, the accelerating force of the springs, at a distance $d = m\,g = m \times 32$ feet per second per second, per second. Now remove the weight m so as to let the force F act on M and M only. Then, if the pans be set oscillating, we shall have an accelerating force which, at a distance d, is equal $m\,g$; which varies as the distance of oscillation of the pans from rest, and which acts on a mass of matter consisting of the beam of the balance and the two equal masses M. Neglecting the balance beam, which we may do if it is light and M is big, our formula now becomes $t = \pi\sqrt{\frac{d \times 2M}{m\,g}}$; from which the time of oscillation can be calculated. The balance may be made of a bamboo cane, braced with an upright rod, and some fine wire, and with a round steel shaft through it, resting on two smooth glass surfaces. Of course, the result will be only approximate, but by varying the masses the truth of the law can easily be established. It will be observed that the time of oscillation is

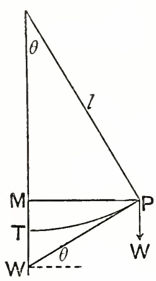
uniform, and independent of the amplitude of the oscillation.

This is an important result, and will prove of considerable assistance in the estimation of the times of vibration of bodies in curved paths, such as the bob of a pendulum.

For the law will hold true whether the path be straight or crooked, provided only that the moving force at all points always acts along the path and is always proportional to the distance measured along the path from a centre. Thus, the smooth frictionless bead threaded on a rod, and with a spring attached to each side of the bead, and whose other end is fastened to the rod, has a time of vibration that is uniform, no matter what the amplitude of its vibrations may be. The velocity will vary inversely with the distance of the bead from the centre. With a curved rod, of course, centrifugal accelerations would be produced as the body slid along the curve. But as these accelerations would be normal to the curve, and perpendicular to the direction of motion they would not affect the time of passage of the body along the curve.

We are now in a position to be able to attempt the solution of the motion of a simple pendulum.

FIG. 24.



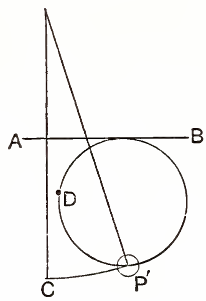
It may first be observed that if a mass m suspended from a string, and oscillating through a small angle, say of three degees, is moved by gravity, the force acting on P resolved along the curve is W sin θ, therefore g sin θ is the acceleration along the curve which that force exerts when the particle is at P, but $\frac{PM}{l} = \sin\theta$. Therefore acceleration down the curve $= g\,\frac{PM}{l}$.

If the angle θ is small, P M is very nearly equal to the arc P T, whence the acceleration at P acting along the curve is very nearly equal to the distance of P from T, and therefore the motion of P about T will be harmonic. Hence it follows that the swing (if the arc be small) is very nearly isochronous.

The isochronism of the pendulum was observed by Galileo when quite young. The only use he made of it was for a machine for doctors to estimate their patients' pulse-beats. His son applied it to a clock.

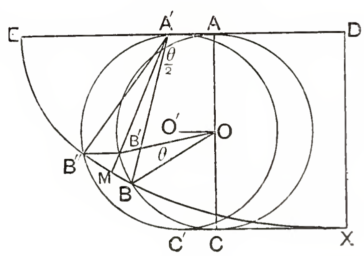
It was, however, reserved for Huygens to show that true isochronism could only be obtained when the path of the bob was, not a circle, but a cycloid, the diameter of whose

FIG. 25.



generating circle had to be one-half the length of the pendulum, and the straight line on which it should roll had to be drawn horizontally through the middle of the pendulum rod. Then, taking the lowest point on the circle (which corresponded with the position of the centre of the bob), and rolling the circle on the line A B, the bob traced out a cycloid. A cycloid is a curve traced out on a flat surface by a point on the rim of a wheel that rolls on a straight line in that surface. A waggon wheel with a nail in the rim would trace out a cycloid upon a wall.

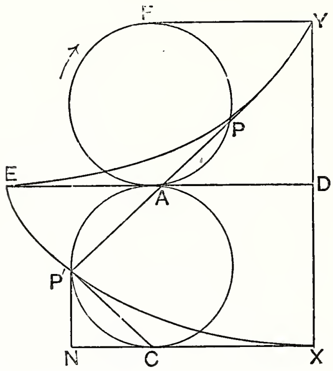
FIG. 26.



Let A B C be a circle of radius a, rolling on the line D E. Suppose it rolls round its centre through an angle B O B′ $= \theta$ so that B comes to B′; then B B′ $= a\,\theta$. But while the circle is turning through an angle θ, at the same time the point A will have progressed to a distance $=$ A A′ $= a\,\theta$, and the point B on the curve will have been carried to a point B″, where

$B'B''$ is parallel and equal to AA', and hence $= a\theta$. But since $B'B = B'B''$, therefore $BM = MB''$. Now, in the limit, BB'' represents the increment of growth of the length of the curve, while $BM = \frac{1}{2} BB''$ represents the growth of the line BC. Therefore, starting from the origin, the length $X'B$ along the curve is always twice the tangent BC drawn to meet the horizontal line CX'.

FIG. 27.

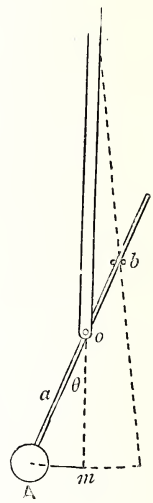


If a second cycloid be traced by a circle rolling on a line F Y, parallel to D E, then P P′ is always tangential to it, and normal to the cycloid E X, whence the arc $EP = 2AP = PP'$, and the cycloid E X is an involute to the cycloid E Y. So that if a string be fastened at Y, and wrapped round Y E, a point E in it, will, as the string is unrolled, trace out the equal cycloid E X; and $DX = 2a$, $DE = \pi a$, $XY = 4a$ and $P'X' = 2PC$.

We will now investigate the motion of a simple cycloidal pendulum, and afterwards that of an ordinary circular pendulum, suspended by a spring.

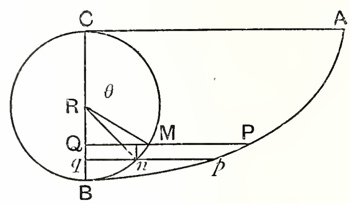
Suppose that at P′ there is a heavy particle, and that it rests on the curve, and is subject to the action of gravity acting downward along P′ N. Then the accelerating force on P′, estimated along the curve, that is along the tangent line $P'C = g \cos NP'C$. But the angle $NP'C = P'CA$, whence $\text{Cos } NP'C = \frac{P'C.}{2a}$ Wherefore the accelerating force produced by gravity resolved along the curve $= \frac{g}{2a} P'C$. But it has just been shown that $P'C = \frac{1}{2} P'X$. Therefore, the accelerating force resolved along the curve $= \frac{g}{4a} P'X'$, that is to say, is proportional to the distance from X′, measured along the curve, so that we have a particle moving along a path, under the action of gravity in such conditions that the accelerating moving force on it along the path at any point is always proportional to the distance measured along the path from its lowest point X. It therefore follows that a swing from one side to the other will be performed in a time $T = \pi\sqrt{\frac{4a}{g}}$ and independent of the length of the excursion of the particle on each side of the point X.

FIG. 28.



If then we were to arrange a system of rods as shown in the figure with an arm $oA = o{\cdot}b$, the motion of A would roughly approximate to a cycloid. The above proof leads us to expect from the nature of a cycloid, that oscillations in that case may be expected to be isochronous. We will now proceed to investigate the motion of a cycloidal pendulum more rigidly, and afterwards that of an ordinary pendulum suspended by a spring.

FIG. 29.



Let us suppose that a curve of any kind is drawn from A to B, and that a weight, P, slides down it without friction under the action of gravity, starting from rest at A to the point P. Let the vertical height of A above $P = x$. Describe a semi-circle on C B, and let Pp be a small part of the path down the curve, A B,

which may be of any form. Complete the figure, and suppose that as P slides down from A to B, the radius, R M, moves round from R C to R B, so that M is always on the same horizontal level with P.

Let the angle C R M $= \theta$. C Q $= x$. C B $= h$.
Also let P$p = ds$. Q$q = dx$.

Then from the geometrical properties of the circle

$$dx = \mathrm{M}n \sin\theta = \frac{h}{2}\, d\theta \sin\theta$$

$$x = \mathrm{CQ} = \frac{h}{2}(1 - \cos\theta)$$

$$h - x = \frac{h}{2}(1 + \cos\theta).$$

From the general equations of motion previously given, we have

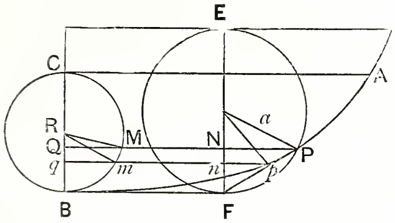
$$dt = \frac{ds}{v} \quad (1)$$

and v (the velocity along the path at P)

$$= \sqrt{2gx} = \sqrt{gh\,(1 - \cos\theta)} \quad (2)$$

These equations and relations are true whatever the nature of the curve A P B may be.

FIG. 30.



Suppose that A B is part of a cycloid of which E P F is the generating circle with radius $= a$. Our object will now be to get an equation containing only values of the variables, t and θ, namely, the time down the cycloid corresponding to a rotation of the circle C M B round its centre. By the property of the circle, E P F, is a right angle, and by the property of the cycloid already examined, the line P F is a tangent to the cycloid at the point P.

$$\text{Hence } \frac{ds}{dx} = \frac{\mathrm{EF}}{\mathrm{FP}}$$

$$\text{But by geometry } \frac{\mathrm{FP}}{\mathrm{FN}} = \frac{\mathrm{EF}}{\mathrm{FP}}$$

$$\text{whence FP} = \sqrt{\mathrm{EF.\ FN.}}$$

and by substitution

$$\frac{ds}{dx} = \sqrt{\frac{\mathrm{EF}}{\mathrm{FN}}} = \sqrt{\frac{2a}{h - x}}$$

whence

$$ds = dx\sqrt{\frac{2a}{h - x}} = \frac{h}{2}\, d\theta \sin\theta \sqrt{\frac{2a}{\frac{h}{2}(1 + \cos\theta)}} \quad (3)$$

Therefore, by combining equations (1), (2) and (3),

$$dt = \frac{ds}{v} = \frac{\frac{h}{2}\, d\theta \sin\theta \sqrt{2a}}{\sqrt{\frac{h}{2}}\sqrt{1 + \cos\theta}\sqrt{gh}\sqrt{1 - \cos\theta}}$$

$$= \sqrt{\frac{a}{g}}\, d\theta.$$

If, then, while P moves from any point A on the curve down to B the lowest point, we integrate the whole motion, we shall have to integrate the expression $\sqrt{\frac{a}{g}}\,d\theta$, between the limits $\theta = o$ for the point A, and $\theta = \pi$ for the point B. Whence

$$\mathrm{T} = \pi\sqrt{\frac{a}{g}}$$

This, then, shows that for a given cycloid the time of descent is independent of the point from which the body sliding down it starts to fall, and the curve is isochronous.

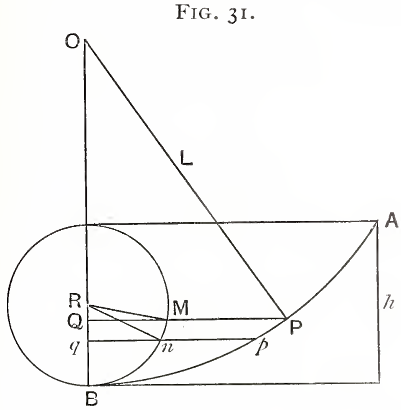
For very small arcs the circular path of an ordinary pendulum bob is very like the curve of a cycloid, the radius of whose generating circle is $\frac{1}{4}$th the length of the pendulum. Hence, for a pendulum of length L the time of a complete swing from right to left is approximately

$$= 2\pi\sqrt{\frac{\frac{1}{4}\mathrm{L}}{g}} = \pi\sqrt{\frac{\mathrm{L}}{g}}$$

g at London $= 32{\cdot}19078$ feet per second, per second $= 981{\cdot}18$ centimetres per sec. per sec., according to Captain Kater's measurements in 1818, which, on the whole, appear the most reliable. The length of the seconds pendulum in London will therefore be $39{\cdot}13929$ in $=$ $99{\cdot}416$ *c.*

The above calculation has, however, assumed that the pendulum moves in a cycloid. This

FIG. 31.



is not strictly true; its path is more nearly an arc of a circle, from which form it only diverges by reason of the elasticity of the spring from which it is hung.

If the arc A B is an arc of a circle with O as centre, and radius $OA = L$, then we shall have the general equations of motion down a curve (1), (2), as before, but we shall now have to introduce equations which depend not as before on the property of a cycloid, but on the properties of a circle.

$$\text{hence } \frac{ds}{dx} = \frac{OP}{PQ} = \frac{L}{\sqrt{L^2 - OQ^2}}$$

$$= \frac{L}{\sqrt{L^2 - (L - (h - x))^2}}$$

$$= \frac{L}{\sqrt{2L(h - x) - (h - x)^2}}$$

$$= \frac{L}{\sqrt{2L\frac{h}{2}(1 + \cos\theta) - \frac{h^2}{4}(1 + \cos\theta)^2}}$$

$$\therefore\ ds = \frac{\frac{h}{2}\, d\theta \sin\theta}{\sqrt{Lh(1 + \cos\theta) - \frac{h^2}{4}(1 + \cos\theta)^2}}$$

$$\text{and } dt = \frac{ds}{v} = \frac{\frac{h}{2}(d\theta)\sin\theta}{\sqrt{gh(1 - \cos\theta)}\sqrt{Lh(1 + \cos\theta) - \frac{h^2}{4}(1 + \cos\theta)^2}}$$

$$= \frac{1}{2}\sqrt{\frac{L}{g}}\, d\theta \left(1 - \frac{h}{4L}(1 + \cos\theta)\right)^{-\frac{1}{2}}.$$

Expanding the last expression we have
$dt = \frac{1}{2}\sqrt{\frac{L}{g}}\, d\theta\ (1 + \frac{h}{8L}$ + a number of other terms involving higher powers of N.

$\frac{h}{8L}$ will be very small if the swing is not large. For an ordinary pendulum bob does not rise much as it swings, whence, then, as h is small, the terms after $\frac{h}{8L}$ will be so small as to be quite negligible. Wherefore, integrating the expression on the right hand between the limits $\theta = o$, and $\theta = \frac{\pi}{2}$, we shall have

$$T = \pi\sqrt{\frac{L}{g}}\left(1 + \frac{h}{8L}\right)$$

where T is the time of a complete swing from one side to the other.

It must be remembered that this formula is not of use for determining the length of the theoretical simple pendulum, because since t and L are easily observed, and g is very difficult to measure, g is always got from t and L. In other words, the accelerative force of gravitation is measured by observing the swing of a pendulum. Once, however, g has been ascertained for one latitude by means of a peculiar form of pendulum specially designed by Captain Kater, we can compute it for all latitudes, and use the formula above given to calculate the length of any desired pendulum, remembering that with an ordinary seconds pendulum $\pi\sqrt{\frac{L}{g}} = 1$, and remembering that the circular error, that is to say, the proportional increase of time of swing due to the arc being circular, is $\phi = \frac{h}{8L}$ seconds.

If m is the semi-arc of swing estimated in length, measured at the centre of oscillation of the bob, then $\phi = \frac{1}{16}\frac{m^2}{L^2}$ or $\frac{m^2}{16\,0000}$ so that if $m = 3$ centimetres, the daily circular error $= \frac{86400}{160000} \times 9 = 4{\cdot}8$ seconds.

Now, suppose that the semi-arc m is increased by a small increment m', then $(m + m')^2 - m^2 = 2\,m\,m' + m'^2$. But if m' is small m'^2 may be neglected. Hence, if t' be the increase of time, caused by increasing the same arc from m to $m + m'$ then

$$t' = \pi\sqrt{\frac{L}{g}} \times \frac{2 \times m \times m' \times 86400}{160000}$$

$= 1{\cdot}08\ m\,m'$ for a seconds pendulum; m being the semi-arc, and m' its increase, estimated in centimetres at the centre of oscillation of the pendulum.

Hence, for instance, if the semi-arc $= 3\ c$, then a difference of arc of $\cdot 38\ c$ would pro-

duce an error of 1 sec per diem. If the semi-arc $= 5$ *c*, then a difference of $\frac{1}{10}$ sec. a day would be produced by a difference of arc of ·0185 *c*, a very small quantity. This example shows that it is very necessary to keep the arc constant, since so small a variation of swing produces such errors. It shows also how desirable it is to use a heavy pendulum vibrating through a short arc, rather than a light pendulum vibrating through a large arc, provided only that the bracket to which the pendulum is attached is exceedingly rigid. This also shows us that the common pendulum vibrating in a circular arc of the usual size needs to be shorter than the theoretical pendulum moving in a cycloid by about ·012 *c*. to allow for the circular error.

Unfortunately, different measurements of the length of the pendulum have not been found to agree very well with one another. Thus General Walker, in 1890 ("Phil. Trans."), was of opinion that a second pendulum made 1·22 seconds a day more vibrations at Kew, than at Greenwich. This would correspond to a difference in *g* of ·028 feet per second per second, a difference greater than would be given by the formulas given above.

These differences show than when a pendulum is taken from one place to another, and from one altitude to another, adjustments must be made amounting, in Great Britain, to 5 or 6 seconds per day of difference, and this is to remembered when clocks are sent to a distance. For if we take the formula $t = \pi\sqrt{\frac{L}{g}}$ it is obvious that there being 86400 vibrations in a day, one second acceleration is caused by an increase of $\frac{1}{2} \times \frac{1}{86400}$ths. part in gravity, that is to say, ·005 centimetres per second per second, so that for each increase in the value of *g*, of onecentimetre per c. per second, we must expect a gain per diem of about 44 seconds a day for the clock.

The differences in the value of *g* in different parts of the world are considerable. Thus :—

In Leith it is	981·58
In Unst (Shetlands)	981·99
In Boston (America)	980·38
At Lick Observatory	979·66
At Paris	980·92
At Calcutta	978·78

So that a pendulum clock which kept time in London would in Calcutta lose nearly 2 minutes a day, and require the pendulum to be shortened by about $\frac{1}{8}$th of an inch.

THE INTERNATIONAL RUBBER EXHIBITION.

It can hardly be doubted that the International Rubber and Allied Trades Exhibition which, after being open to the public for a fortnight, closed last Saturday, will be of lasting importance to the rubber industry. It was the first rubber exhibition held in Europe, and it was claimed for it that it was the first "complete" rubber exhibition ever held. For it contained not only specimens of the raw product from the time of its issue in the form of juice or latex from the bark of the tree through all the stages of its preparation down to the fully manufactured article, it also exemplified the growth and cultivation of the trees from which the rubber is obtained, and the machinery used for the many goods manufactured from india-rubber. How many they are few know who are not in the trade. Its value as a flexible insulator, its resilience, and its practical indestructibility are acknowledged and day by day its uses are extending. Great as has been the extension of the past it is but the beginning of a still greater expansion. In 1830 the import of rubber to England was represented by 464 cwts. In 1907 it had increased to 33,364 tons. Plantation rubber is increasing in importance. In 1905 only 150 tons was received in London, last year the import amounted to 1,100 tons, and year by year it must increase, for in addition to the extensive plantings which have already taken place in Ceylon and British Malaya, and India, there are now large areas under rubber in the Dutch East Indies and Borneo, whilst on the other side of the world planters in Mexico, Nicaragua, Columbia, Ecuador, Peru, and Honduras, have put extensive tracts under rubber, and the West Indies are also planting rubber rapidly. But as yet plantation rubber forms only a very small proportion of the world's output. Close upon two-thirds of the world's supply of rubber, which last year amounted to 69,000 tons, still comes from the wild trees of tropical America, Brazil alone yielding about one-half the total.

There was a very fine display at the Exhibition by the Brazilian Government of the raw rubber as it is received in this country in cakes or balls, many of them of large size. The weight of rubber brought together in the Brazilian Court was estimated at 10,000 lbs., and many of the samples shown were of the standard quality known as "fine hard Para." There was one bale weighing no less than 260 kilogrammes shown by Messrs. Mello and Co. of Para and Manaos. All the Brazilian rubber is being extracted out of wild growing forest trees. Rubber plantations are up to now rare in Brazil although a beginning in that direction has been made. The Straits Settlements had a very interesting display of the various kinds of raw rubber produced in the colony. Para rubber (*Hevea brazilensis*) was introduced in Ceylon in 1876, and since 1900—when it first received serious general attention—has grown with remarkable vigour. Experts maintain that the growth of the tree is nowhere more satisfactory than in the Malay Peninsula. In

the Brazil section of the Exhibition there was a typical shed formed of palm leaves in which the rubber hunters prepare the latex and coagulate it by exposure to heat and smoke, and the Straits Settlements had also a full sized model of a Malay house.

The Netherlands section of the Exhibition was very complete. The rubber industry of the Netherlands is limited to some few factories, but the allied industries, such as the manufacture of lacquer and varnishes are carried on extensively, and the manufacture of asphalt is also of importance. It is only during the last years that the Netherlands colonies in Asia have attracted attention as a promising rubber country. The collection of the Netherlands at the Exhibition was more varied in character than any other. It included samples of gutta-percha produced from the Dichopsis, both in the solid rolls as obtained by tapping, as also in the form of fibre or scrap extracted from the leaves of the tree. It is claimed that the quality of the gutta-percha produced by the leaves is quite as good as that from the latex. Mexico has made great strides of late in the cultivation of rubber, and she can now boast of the largest and most carefully cultivated estates of any rubber-producing centre, directed by skilled scientists ready and anxious to adopt the latest and best methods for planting, tapping, and preparing the rubber, and in this way they have of late years exported some of the finest rubber produced. It was estimated a year ago that the world's area of actual rubber plantations was 355,000 acres, and of these 95,000 are in Mexico, the Malay Peninsula coming next with 92,000. In the Mexican collection at the Exhibition there were many castilloa trees at different ages, specimens of the latex and rubber obtained from the castilloa, and illustrations of the method of close planting practised in Mexico.

Among the rubber exhibits from British colonies, Ceylon takes a prominent place, the Ceylon collection of biscuit and crêpe rubber being exceptionally good. There was also an interesting display made by the Madbira Forest (Uganda) Rubber Company with samples of the latex of the *Funtumia elastica*, and many specimens of crêpe and corrugated sheet rubber, photographs of the forest, examples of the timber. and the growth of the rubber-producing trees. The exhibits of the British West Indies section were arranged by the West Indian Committee, and show that rubber cultivation is making headway in the islands and British Guiana. Trinidad began exporting in 1906, and with the area rapidly coming into bearing, the increase in the near future should be rapid, Dominica, St. Lucia, and British Guiana were also well represented at the Exhibition.

Rubber in its crude state is of no value. Before it can become valuable it must go through various refining and disintegrating processes, and after its transition to a condition of unalloyed refinement it is useless for transformation into various marketable goods and articles without the aid of vulcanisation in some form or other. Without vulcanisation the development of the rubber industry as it exists to-day would have been impossible, and the use of rubber would be restricted to a very narrow area of application. One of the most interesting displays at the Exhibition was that of the India Rubber, Gutta Percha and Telegraph Works Company, of Silvertown. The floor of its court was laid in a mosaic form of solid rubber, and it is claimed for this rubber tiling, which is very beautiful, that it is almost indestructible, and that it has the appearance of marble. The company showed also the evolution of the rubber tyre from the early days of the solid tyre down to the latest development of the pneumatic tyre, and the ribbed-tread Palmer tyre, made by this company. Also the history of the development of the carriage and motor tyres is shown in a series of models, and much else that is of interest to those concerned with the rubber industry.

It has been complained of late, not perhaps without reason, that exhibitions are kept open less with a view to the furtherance of trade interests than with the object of attracting visitors and achieving success from the receipt of gate-money, and the committee appointed by the Board of Trade to make inquiries in reference to the value of exhibitions lent the weight of its authority to this view. The Rubber Exhibition was free from this taint. There were no "faker" stands or side-shows. It was sought to attract the class of visitors who would benefit the exhibitors and there is reason to believe they were attracted.

AN INQUIRY INTO THE FEEDING HABITS OF BRITISH BIRDS.*

It is becoming increasingly difficult, with the introduction of scientific methods into agriculture, horticulture, and forestry, for zoologists studying economic problems to form a definite opinion with regard to the economic status of many species of the birds of our islands, such as, for example, the rook, jay, starling, chaffinch and other finches, and many other birds.

This difficulty is entirely due to the almost complete absence in this country of any precise information as to the food habits of our birds. There exists a large amount of evidence obtained from observers, such as fruit-growers, gamekeepers, sportsmen, and others; and although some of this may be and is useful, much of it has been distorted on its way through the prejudiced glasses of the observer. What is really necessary in order to obtain as accurate a conception as possible of the economic status of any species of bird is the actual dissection and recording of the contents of the crops and stomachs of a large number of individuals killed, not only in different months of the year, but also in different localities,

* Abstract of a paper read before the Biological Section of the British Association, Dublin, 1908, by C. Gordon Hewitt, M.Sc.

since different conditions exist in different regions, for example, in Kent and Lancashire.

Such evidence is the only real and safe guide, and observational evidence, after careful selection, must only be taken as supplementary.

Very little work of this nature has been accomplished in this country, but until it is done the regulations with regard to the protection of birds will be ever subject to the influence of the personal bias or ignorance of the legislators, and such legislation will be on as equally a sound foundation as many of the fisheries regulations were until the advent of scientific fishery investigations.

The Biological Survey Bureau of the United States Department of Agriculture furnishes an excellent example of the kind of work that should be carried out; it is collecting and publishing a valuable mass of information concerning the feeding habits of birds and their nestlings, from which, in the majority of cases, they are able to deduce the precise economic value of these birds. The Central Bureau for Ornithology of the Hungarian Department of Agriculture is doing similar work.

It is proposed to form a British Economic Ornithological Committee, as such work can best be carried out by a number of biologists working together. At the last annual meeting of the Association of Economic Biologists, held in April, 1908, the author moved the following resolution, which was carried unanimously:—

"That this Association, recognising the great need of an organised inquiry into the feeding habits of the birds of the British Isles, with a view to obtaining a precise knowledge of their economic status, is of the opinion that a committee should be formed with the object of carrying on investigations on this subject."

The Board of Agriculture, recognising the importance of the subject, have promised to help the inquiry.

THE USE OF AFRICAN ELEPHANTS FOR TRANSPORT SERVICE.

Experiments have recently been made in the basin of the Congo, to train elephants for transport service, for the question of transport appears to be one of the most difficult with which the Congo administration has to deal. The African elephant, heretofore of value only for his ivory, may in future contribute in no small measure to a solution of the problem in regions difficult of access by other means. The experiments which have been carried out, up to the present, show that elephants can be used to advantage for porterage work in regions where the opening up of the country is most difficult, because of lack of transportation facilities. Contrary to the general belief that Central African elephants could not be tamed, and made to perform the same service as their Asiatic fellows in India, a bulletin is stated by the American Consul at Boma, to have been issued by the Congo Government, announcing the complete success of certain experiments conducted at an "elephant farm" at Api, in the Uele district, in the northern section of the Congo State. Here a small herd of young elephants has been found in captivity for several years, and finally after much effort in training them satisfactory results have been obtained. The director of the elephant station, in an official report, says that these experiments demonstrate that the African elephants can live in captivity, and that by good treatment they can be induced to perform labour. Already the oldest members of the elephant farm at Api execute the porterage and traction work of the station. They carry drivers on their backs, and pack saddles with loads. None of the animals are more than seven years old, and since the Indian elephants are most efficient at the adult age, 15 years, it is believed that even better results may be looked for. Mortality among the elephants newly captured has been great, and as yet it has not been possible to attempt to breed them in captivity, but experience is solving the problems of taming; the deaths are now few, and fresh recruits are constantly being added. With a beginning thus made the scope of the work at Api will doubtless be enlarged, and eventually it is expected elephant caravans will be established. Success in the undertaking means a great deal for the future of the country. Despite railways and steamship lines, the Congo will always be a country of forests and of savannas intersected with swamps. European stock does not survive in the tropical heat, and native carriers can be employed only to a certain extent. The elephant is not affected by the tse-tse fly; it can ford the most steeply embanked and rapid streams, and, of still greater importance, it can cross the swamp lands encountered so frequently in the Upper Congo, and so often a barrier to men on foot. In establishing lines of communication to the regions so difficult of access, and to supplement the regular commercial routes, elephants may prove indispensable. They should be of even greater value to the white man penetrating Central Africa than in the jungles of Hindustan. Probably in no part of Africa are elephants found in greater number than in the basin of the Congo. Recoiling before the advance of civilisation, herds which once thickly occupied all the humid countries of Central Africa, are now thinning or else gathering in regions inaccessible to hunters. They still range freely in many parts of the Congo, though not easily found near posts long established. White hunters must obtain, at a cost of £20, a permit for killing them as game, or for ivory, and the number allowed to be killed by each hunter is limited, as well as the time validity of the permit. Natives must also obtain permission to kill elephants. By these provisions, wholesale slaughter is in a measure checked, and the supply of ivory thus partially preserved. But for the permanent preservation of this source of wealth and of the species, the experiments in taming at Api also have their value. By closely studying the habits and characteristics of Central African elephants in the work

at the Api farm, much information of scientific value about the comparatively little known Congo variety was obtained. In the region of vast plains cut by rivers and swampy streams of the Uele district the elephants thrive. They live especially in the marshy regions, feeding on the grass of the plains in the early morning, and returning to the shelter of near-by forests when the sun's rays grow warm. Rarely are the solitary "rogue" elephants met in the Congo. The African species are found generally in families, of three to six animals, but troops of 20, 30, or 100 are not rare, and witnesses even affirm that troops of several hundreds exist. Shunning man, and as a rule fleeing at his approach, the African elephant when attacked often shows fight and is dangerous. Congo specimens have, to a marked degree, the characteristics which distinguish them from the Asiatic species. These, to outward appearance, are particularly the form of the skull and the very large ears. The latter even stretch back beyond the neck, and cover part of the flank. In colour, the Congo elephants are of a grayish blue, almost of a slate-like tint. No one has ever reported seeing specimens of the sacred white elephant of India, in the Congo. As regards size, Congo elephants have been killed more than 14 feet high at the withers and reckoned at more than eight tons in weight. Tusks obtained are sometimes more than 200 lbs. in weight and six-and-a-half feet in length.

THE USE OF REED LATHS IN SWEDEN.

Although Sweden is a country of unusually extensive forests, in proportion to its size, and is therefore better able than many other countries to stand a strain upon its wood products, it is found there that certain reeds form a much cheaper material than wood laths, in the plastering of ceilings and wooden walls of buildings. These reeds are of the common kind, and they grow wild in large quantities almost everywhere in central and southern Sweden, on the borders of lakes, ponds, rivers, smaller water-courses, and in marshy places. The reeds are used both in the raw state and in the form of a woven sort of matting, according to the customs and preferences of the builders. One method is where the reeds are woven into a matting which is much more readily nailed to the walls and ceilings than where each reed is nailed on and wired by hand. According to the American Consul at Gothenburg, the plant from which this reed grows is known by several names in Sweden, but it is most commonly called "vass" or "vassrör." It seems to thrive best in shallow water, on the edges of lakes, but it is also sometimes found as a weed among growing grain on low ground. It is the largest of the wild grasses in Sweden, and is considered good fodder for cattle, for which purpose it is often cut green. The tops are also sometimes cut off before they go to seed, and are then used by farmers as stuffing for beds and mattresses. The full-grown reeds are about seven or eight feet above water, and when they are to be used as a plaster-fastening material, they are cut in winter, after the leaves have dropped off and the lakes have been frozen over. They are never harvested in boats. The frozen surface of the lakes makes the reeds much more accessible than if they had to be reached through water or swampy land, but they should be cut as early as possible before the snow has broken them. The reeds are not cultivated in Sweden, but are regarded as so common that it is impossible to procure the young plants or the seeds except by giving a special order for some one to go into the country for them at the proper season of the year, the spring for the plants and the autumn for the seed. There are no special purchasing agents or concerns in Sweden for the harvesting of the reeds. On the largest number of farms, where such reeds grow, the farmers themselves cut the reeds and sell them to the so-called rivetting factories. The prices vary considerably in different years. On the average a bundle with a cross section of ten inches at the lower tie or brace, about one foot from the root end, costs, delivered on the railway trucks, fourpence to fivepence. The reeds are also often bought in lots of twenty bundles, each bundle being about two feet in circumference, and cost about 4s. 6d. a lot. The mats are of different widths, from one to two yards, according to the length of the reeds. They contain about twenty square yards, and have a selling price at the factory of about two shillings per mat. It is impossible to state with accuracy the number of mats made and sold in Sweden each year. The results of careful examination show that these laths are just as durable as wood laths. In the case of houses, at least seventy years old, which have been pulled down, it has been found that the reeds nailed to the walls were just as sound as when they were put there. All depends, however, upon the manner in which the reeds are harvested and kept, because they are easily damaged if the bundles are kept wet or covered with ice. Wood rivetting mats are scarcely manufactured any more in Sweden because they are too expensive. Besides that, the reed mats are considered better and more practical, because when such are used, the plastering does not crack, which was often the case when unseasoned wood laths were used. So-called loose reeding is used a great deal, that is the loose reeds are nailed to the walls and ceilings by hand. If skilled workmen are available, such reeding can be just as effective as the mats. Whether the one or the other of the two systems is used depends a good deal upon the custom of the respective building contractors. The old ones, among whom there are many who hold on to old methods, prefer the so-called loose reeding. The use of reed mats is increasing as compared with the use of loose reeds. The supply of reeds in Sweden is very large, and much in excess of the home demand, so that great quantities which are never harvested could be available for export.

HOME INDUSTRIES.

Post Office and National Telephone Service.—Telephone workers are very uneasy at the prospect of numerous discharges in connection with the coming transfer to the Post Office. About a thousand men have been paid off up to the present, and it is expected that a much larger number will have to go. In deciding the basis of valuation for new plant the Post Office authorities seemed to have overlooked the fact that they are taking over a growing business. Obviously it will not pay the company to put down plant that will only be brought into use when the Post Office has come into possession. The company cannot, as things are, continue to develop its business at the normal rate up to the time when the lease lapses. The laying down of new plant will be stopped, with consequent discharge of men. The public as well as the workmen are likely to suffer. The company is providing for the increase of business at the usual rate up to the end of 1911. But in the following year the majority of the exchanges will be full in respect both to switchboards and underground plant, and the Post Office will be unable to connect new subscribers. If they were to start the work at once it would take three or four years to get the necessary plant put down. And quite possibly the Post Office, taking over such an immense undertaking, will not be able to apply itself immediately to the task, which may mean a further delay of a year or eighteen months. If these forecasts are near the mark, there will be a period of from four to five years in which the development of the telephone system will make little or no headway, even assuming that the company does not underestimate the requirements to the end of 1911, as there will be temptation to do. The difficulty would be got over if the Post Office would agree to meet the company in respect of capital charges in connection with new plant that could not be brought into use until after the expiration of the company's lease.

Insurance against Loss by Bad Debts.—Insurance companies and business men have often considered the question of loss by bad debts without being able to devise a scheme that, whilst fulfilling the requirements of the assured, would enable the companies to undertake the risk upon satisfactory conditions. It is necessary for the insurance company, when it guarantees a firm against bad debts, to require the assurance that during the period of insurance the firm will exercise the usual caution and judgment in giving credit. In order to secure this the policy is provided with so many irritating provisions that the insurance becomes an impossibility. In America the difficulty has been more or less met by the institution of a "guarantee account." The agents undertaking the sale of the productions of a manufacturer will, on receipt of a somewhat higher rate of commission, guarantee him against bad debts in respect to all such sales, the sales being passed through the agent's book, thus enabling them to deal directly with the accounts. This method of insurance has brought into existence what is known as a "credit man," whose function it is to give to his employees (the selling agents) expert and up-to-date advice as to the financial standing of the firms dealt with. Some agents pay the manufacturer on short terms for all goods they invoice, even though sold on long credit, charging the current rate of interest on the accounts from the date of payment to the actual due date. The advantage to the manufacturer is that the agent who insures him against loss is also materially interested in promoting the sale of his goods, and he comes into direct personal contact with the men for whose honesty and solvency he is vouching. This kind of agency business has become very popular in America, being equally satisfactory to producer and seller, but as yet it has made no headway in the United Kingdom.

Scotch Whiskey.—The Scotch whiskey trade still labours under great depression, but official statistics for the last financial year indicate improvement in the position. The output of the 150 distilleries situated in Scotland amounted to 22,796,000 proof gallons, a decrease of 2,043,000 gallons as compared with the previous year, and of 12,972,000 gallons as compared with 1898-9, when there was a record output. The result of the reduced output is that the stocks in the bonded warehouses in Scotland have been reduced to 115,649,000 gallons, equal to between five and six years' consumption. The consumption of Scotch whiskey is not at the moment increasing, taking the world's demand, it being practically stationary at slightly over 26,000,000 gallons, which, however, is an increase of nearly 20 per cent. as compared with ten years ago. The industry is still suffering from the reckless doings of that time, when the stocks were out of all proportion to the requirements of the trade. It is expected that stocks will be further reduced this year by curtailment of production during the coming distilling season.

Copper Rollers.—At the recent general meeting of the Calico Printers' Association, the Chairman stated that part of the capital outlay during the past year was due to the laying down of three new plants for coppering rollers. It may seem strange that coppered rollers are not more commonly used. Copper rollers lock up a considerable amount of capital in a print works which might be saved by the use of coppered rollers. But it is impossible to get the best results in high-classed mill work except on copper rollers, and the pattern on a solid copper roller can be turned off and the roller re-engraved much oftener than on a coppered roller. This requires frequent recoating, so that if the patterns engraved are unsuccessful and have short runs only, a considerable amount may be ultimately added to the original cost of the roller for the re-depositing operations. These rollers are, therefore, confined mainly to shipping styles, which usually have long runs, and do not require high-class en-

graving, though for very large roller work they are almost invariably employed.

The World's Coal Output.—The Antwerp Bureau of Commerce has just published its annual figures of the coal output of the world. The world's total coal output for 1906, the last year for which definite results have been obtainable, was 893,249,557 tons, as against 844,194,217 tons in 1905. In 1896, the total was 546,742,207 tons, in 1886 it was 303,207,780 tons, in 1870 it was 203,321,112 tons, and in 1850 only 89,881,357 tons, figures that bear eloquent testimony to the expansion of the world's industries. The United States take the first place as a coal-producing country, its total output for 1906 being 375,397,000 tons, or more than 42 per cent. of the total. This place it has held since 1899, when it wrested it from this country. Great Britain comes next with a record of 251,050,000 tons, over 28 per cent. of the total, and Germany third with 136,480,000 tons, about 15 per cent. of the total. France makes a poor fourth, with 34,313,000 tons. Japan and Canada, though as yet far behind the output of the four countries quoted, show great expansion in output during recent years, Japan having increased her production from 1,243,000 tons in 1905, to 12,500,000 tons in 1906, while the Canadian production has increased five times during the last twenty years, the output for 1906 being 9,916,000 tons.

Labour Troubles.—The engineering trouble on the North-East Coast is over, and the men, or such of them as are wanted, have returned to work. At the ballot which was to determine whether they should accept the masters' terms, or continue the struggle, surrender was agreed to by a majority of 870, there being a small majority for peace in each of the three societies. The men return to work at the reduction of $2\frac{1}{2}$ per cent. in piecework rates, and 1s. per week in time wages demanded by the employers. Unless these terms had been accepted without further delay, a national lock-out was to have been proclaimed by the federated employers. As it is, this great calamity has been averted. No further alteration in wages is to take place for six months, and the men's representatives are to attend a conference with the representatives of the employers for the purpose of considering in what respects the present procedure for dealing with the wages question shall be amended in order to avoid stoppage of work. The first meeting is to take place within one month after the resumption of work. Unhappily the hope, and even expectation, expressed in these Notes, that the dispute in the cotton trade would be adjusted, has not been fulfilled. The operative spinners agreed to the 5 per cent. reduction, but the card-room leaders refused, and the result is a lock-out in the cotton trade, the end of which no man can foresee. It is most earnestly to be hoped that counsels of moderation will before long prevail, and that the dispute will lead to some arrangement being made whereby advances and reductions of wages will be arrived at automatically according to variations in the state of trade.

GENERAL NOTES.

Lubricating Oils in Austria-Hungary.—The Standard Oil Company and the Vacuum Oil Company, as a combine, control the markets for lubricating oils in Austria-Hungary. They have refineries in both parts of the Empire, with a joint capital of £1,000,000. They are now acting, says Mr. Consul Faber in his report on the trade and commerce of Fiume, just issued (No. 4099, Annual Series) in a combine with the Galician oil refiners, and cut out all competition, even in the retail trade. The imports of British lubricating oils do not exceed 600 barrels, and all direct imports from America are for the account of the combine.

Technical Optics.—The Governing Body of the Northampton Polytechnic Institute have established Day Courses in Technical Optics for the training of youths, not less than 15 years of age, who are intending to take up, or have already taken up, some branch of optical work as a profession. Full details of the complete course, which extend over two years, will be found in the Institute's "Announcements," for the Session 1908-1909. In addition, there are partial courses requiring an attendance of two mornings per week, for those already engaged in any branch of the optical trade, and also day courses in Mechanical, Electrical, and Horological Engineering, and in Artistic Crafts, as well as evening courses in all subjects connected with these day courses, and in other subjects.

The Suez Canal Traffic.—The report of the Suez Canal Directors upon the traffic of the waterway has just been published and demonstrates the continuance of its great and growing prosperity. The net tonnage for the past year shows an increase of 1,282,930 tons as compared with that of 1906, and an increase of 1,594,329 tons as compared with that of 1905. From the 1st of January, 1906, the rate of transit dues was reduced from 8 fr. 50 c. to 7 fr. 75 c. per ton. This reduction did not reduce the gross receipts which amounted in 1907 to 116,000,096 fr. as against 113,866,796 fr. in 1905 and 108,161,896 fr. in 1906. The increase is not due to abnormal causes but to the general activity of trade. There has been an increase of 1,195,937 tons, as compared with 1906, in the tonnage of British vessels, which amounted to 9,495,860 tons in 1907, as compared with 2,253,651 tons carried under the German flag. The increase in the Canal traffic last year was almost wholly due to the increase in British tonnage, which was more than twelve times as large as the increase in German tonnage. The percentage of tonnage under the British flag has risen from 61·7 per cent. in 1906 to 64·5 per cent. in 1907, whilst the percentage under the German flag has fallen from 16 per cent. to 15·3 per cent., the percentage under other flags having remained almost stationary.

Journal of the Royal Society of Arts

No. 2,916. VOL. LVI.

FRIDAY, OCTOBER 9, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

VIVA VOCE EXAMINATIONS IN MODERN LANGUAGES.

During the present year 28 examinations have been held in London, Manchester, Bristol, Hitchin and Guernsey.

At these examinations 615 candidates presented themselves, of whom 467 passed (163 with distinction) and 148 failed. The languages taken up were French, German, Spanish and Italian.

The results of previous years are as follows:—

Year.	Number Examined.	Passed.	Failed.
1902	280	202	78
1903	456	324	132
1904	540	375	165
1905	681	502	179
1906	644	469	175
1907	629	476	153

The following is a complete list of the *Vivâ Voce* Examinations held during 1908 :—

Place of Examination.	Date.	Number of Candidates.	Passed with Distinction.	Passed.	Failed.
French :—					
Acton and Chiswick Polytechnic	March 27.	22	—	18	4
Hitchin	April 13.	28	—	19	9
Willesden Polytechnic	May 27.	21	5	9	7
The Hall, Ealing Green	May 28.	14	9	5	—
Tottenham Polytechnic	May 29.	48	16	23	9
City of London College (Candidates from London Polytechnics)	June 1.	31	10	18	3
Regent-street Polytechnic (Candidates from London Polytechnics)	June 2.	25	10	13	2
Battersea Polytechnic (Candidates from London Polytechnics)	June 4.	27	7	12	8
Guernsey Education Committee	June 10.	24	9	13	2
French (*continued*):—					
Manchester Education Committee	June 15.	17	5	8	4
Kensington College	June 30.	21	13	5	3
"Barnsbury Park" L.C.C. School	July 3.	18	10	7	1
"Barnsbury Park" L.C.C. School	July 6.	18	8	9	1
L.C.C. Evening School, St. George's-row, Pimlico	July 7.	13	5	5	3
L.C.C. Evening School, Plough-road, Clapham Junction	July 8.	26	5	15	6
L.C.C. Evening School, Sussex-road, Brixton	July 9.	25	6	16	3
L.C.C. Evening School, Blackheath-road, Greenwich	July 10.	14	7	5	2
Merchant Venturers' Technical College, Bristol	July 14 & 15.	74	7	32	35
German :—					
Willesden Polytechnic	May 25.	16	3	8	5
Manchester Education Committee	May 29.	10	3	5	2
Regent-street Polytechnic) Candidates from London Polytechnics)	June 1.	20	9	9	2
City of London College (Candidates from London Polytechnics)	June 5.	17	4	10	3
City of London College (Candidates from L. C. C Evening Schools)	July 8.	16	4	5	7
Merchant Venturers' Technical College, Bristol	July 13.	21	2	12	7
Spanish :—					
Manchester Education Committee	June 2.	12	—	5	7
City of London College (Candidates from London Polytechnics)	June 10.	18	1	8	9
City of London College (Candidates from L. C. C. Evening Schools)	July 9.	9	1	4	4
Italian :					
Manchester Education Committee	June 1.	10	4	6	—
		615	163	304	148

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE THEORY AND PRACTICE OF CLOCKMAKING.*

By Sir Henry Hardinge Cunynghame, K.C.B.

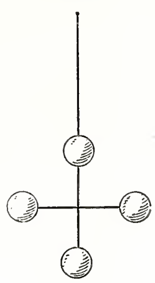
PART III.

Compound Pendulums.

The investigations previously made relate only to simple pendulums, that is, to pendulums which, for the purpose of the calculations, are supposed to consist of a particle having mass, but not size, and suspended by a thread without mass. It now becomes necessary to extend the inquiry to pendulums of different shapes and forms.

From what has gone before, it might be supposed that if the distance from the support of a pendulum to its centre of gravity were made $\frac{g}{\pi^2}$ the time of oscillation of the pendulum would be one second. It is, however, easy by an experiment to dissipate this

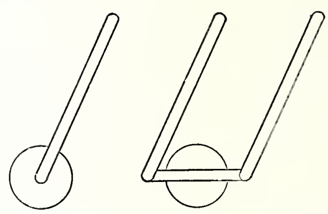
Fig. 32.



idea. For, take a thin rod, and fix four equal arms to its lower part, and on each arm let there be a weight attached by a screw, and capable of being shifted to any point on the arm. First bring all the weights into the centre and fix them, and observe the time of oscillation. Then put each weight at the end of its arm and again swing the pendulum. Its time of oscillation will be found to have increased. Yet its mass is the same, and the position of its centre of gravity is unchanged.

Not only experiment but theoretical considerations will bring this point home. For in adapting the equations for the movement of a simple pendulum to suit the movement of a compound pendulum one is struck with one obvious distinction between them. Suppose that the compound pendulum consisted of a sphere fastened to a stiff rod. Not only must the mass of the rod be allowed for, but it is to be observed that as the pendulum swings the sphere rotates (with respect to absolute space) about a horizontal axis. To make it rotate absorbs momentum. Thus, for instance, if the bob of a pendulum consist of a wheel mounted on pivots in a crutch at the end of the pendulum—if the pendulum is suddenly stopped at the lowest point where its kinetic energy is the greatest, the wheel will rotate. It is obvious that this rotation must be allowed for in our calculations. For it is clear that if arrangements were made so that the wheel which formed the bob should not rotate the apparatus would be a simple pendulum.

Fig. 33.



We have therefore to make a digression into the nature of the laws governing the rotation round an axis of a rigid massive body.

The relationship between pressures which act upon bodies and the movements which these pressures produce in bodies that are free to move, can, of course, be determined by experiment; as for instance, by observing what motion would be produced by the pressure of a certain statical weight applied to masses placed on inclined planes or hung over pulleys. As we have seen, the pressures produce accelerations that can be measured. The pressure produced by gravity on a mass of matter will, if that mass is free to move, cause an acceleration of speed in it of 32·2 feet per second for every second during which the gravity acts.

Every sort of motion may always be resolved into two classes, a motion of translation, and a twist, or motion of rotation.

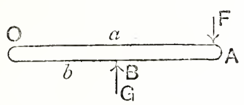
What has been said applies to motions of translation; we have now to examine rotation.

From the principles of statics we learn that the twisting effect of a force is measured by its amount multiplied into its distance from

* The Course consisted of Six Lectures, delivered Jan. 20, 27; Feb. 3, 10, 17, 24. In re-arranging the material for publication, the Lecturer has preferred to divide it into Four Parts.

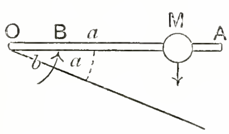
the axis of rotation. This is called its leverage. A continental word has been introduced for it that is not altogether happy, called "moment." The word moment originally meant "importance" or "value," and in that sense the word momentum was used by Newton to express the quantity or value of velocity as applied to masses. The word "moment" has nothing to do with "momentum" and only by accident resembles it. If F be a force, its statical moment $= F \times a$, a being the length of the lever arm by which the force twists the end of the arm round its axis. The pressure G that will be exerted by a moment F a on a point distant b from the axis $= \frac{Fa}{b}$. At first sight this seems very curious.

FIG. 34.



One is inclined to ask how a force F at A can be increased to a force G at b, or again how a force G can be watered down to a force F at a. But this enquiry only arises from omitting to observe that when G presses at B, part of its force is applied at o and part at A. The pressure it produces at $O = \frac{a - b}{a} G$; and is useless for twisting purposes. It is only the pressure on $A = F = G \frac{b}{a}$ that is of any use in the twisting of the arm round F. And this is true dynamically as well as statically. So that if we were asking what

FIG. 35.



acceleration a massive ball M situated at A would receive by the application at B of a force capable of producing an acceleration F in the ball M if it were applied directly on it, the answer would be that the force which, acting at A on M, would give it an acceleration F, is that which, if applied at B in a parallel direction, would give it an acceleration $\frac{b}{a}$ F, and generally a force F applied at a distance b from an axis, will produce in a parallel direction an acceleration b F on a unit mass put at a unit distance from O. Whence, then, we may say that the accelerative effect of pressures in producing accelerations on bodies fixed to an axis is equal to the moments of these pressures round the axis of rotation.

Next we have to inquire from the other side what effect these pressures will have in producing rotation.

In the first place, we have seen that the effect of a rotary acceleration on the mass is minimised in proportion to the distance of that mass from the axis, or, to put it correctly, the inertia of the mass, that is, its power of resisting rotary motion is in proportion to its distance from the axis.

And not only this, but it is also obvious that the effect of motion in producing an angular twist is in the inverse ratio to the distance of that motion from the axis. That is to say, a given linear motion round a circle is of less effect in producing an angular twist in proportion to the distance of that circle from the axis. Hence, then, the inertia to be overcome by any acceleration, is increased in two ways in proportion to the distance of the body from the axis. Not only is any given rotary acceleration less powerful in proportion as the mass moved is distant from the axis, but the acceleration is less effective in producing angular motion. Whence then it results that the resistance to angular acceleration of a mass M at a distance γ from the axis, is in the proportion of $\frac{1}{\gamma^2}$. Or in other words the rotary angular inertia, or as it is now generally called the "moment of inertia," of a body at a distance γ from the axis is $M \times \gamma^2$, and depends on the mass of the body multiplied by the square of its distance from the axis. Whence then it follows that if a force F is applied at a distance a from the axis, its moment Fa will produce on a mass M at a distance γ from the axis, an angular acceleration which is directly proportional to Fa the moment of the force, and inversely proportional to $M\gamma^2$ the moment of the inertia, or in other words $= \frac{Fa}{M\gamma^2}$, and if the body to which the pressure F is applied has a mass M′, and the force like the gravity varies in proportion to the mass, then the force F directly applied to M′ would produce in it an acceleration, f, and we may then say that α (the resulting angular acceleration) $= \frac{M' \cdot fa}{M' \cdot \gamma^2}$.

If we were only considering the effect of gravity on a particle of mass M at a horizontal distance a from the axis, then the moment of pressure would be a. M. g., and the moment of

inertia would be $M.a^2$. Hence the angular acceleration would be $\frac{a.M.g}{M a^2} = \frac{g}{a.}$ And the body would begin to rotate with an angular velocity which would be induced by that angular acceleration. The vertical linear acceleration would, of course, $= g$.

Now, if instead of one mass m, we had a whole number of masses $m_1\, m_2\, m_3 \ldots\ldots$ arranged at various distances $a_1\, a_2\, a_3\, a_4\, a_5$ from the axis, and suppose they were all acted upon by forces which produced in them the same acceleration f. Then the twisting moments of those forces would be $m_1\, a_1\, f$;—$m_2\, a_2\, f$;—and so on. Now each one of these pressures would produce an angular acceleration upon its own mass, and upon each of the others. Thus $m_1\, a_1 f$ would produce on $m_2\, a_2$ an angular acceleration $= \frac{m_1\, a_1\, f}{m_2\, (a_2)^2}$.

Hence, if we wish to examine the total effect of all the pressures on all the particles, it is not sufficient merely to divide the moment of pressure on each particle by the moment of inertia of that particle and then add the result. If we did, this would give as a result merely the addition of

$$f\left(\frac{M\, a_1}{M\, (a_1)^2} + \frac{M\, a_2}{M\, (a_2)^2} + \ldots\ldots\right)$$

$$= f\left(\frac{1}{a_1} + \frac{1}{a_2} + \frac{1}{a_3} + \frac{1}{a_4} + \ldots\ldots\right)$$

But this would be to consider the acceleration on each particle as only acting on its own mass. It would be as though they were all loose on the axis. But they are bound together, and must all go together. Hence the acceleration on each affects all the others, so that we must take the accumulated effect of the moment of pressure of each of the particles on the moments of inertia of each of the others, and then sum the result.

Now, the resulting moment of pressure of the forces $m_1\, a_1\, f$;—$m_2\, a_2\, f$; &c., is obviously $M.a.f.$, where M is the sum of all the masses, and a is the distance from the axis of the centre of gravity of all those masses. For this is the very definition of the centre of gravity, and as this moment of pressure $M.a.f.$ representing the total of all the pressures is exerted on all the particles whose movements of inertia are $m_1\, (a_1)^2$ &c., we shall, in order to get the angular acceleration, have to evaluate the expression:—

$$\frac{M\, a\, f}{m_1\, (a_1)^2 + m_2\, (a_2)^2 + m_3\, (a_3)^2} + \ldots\ldots$$

In order to shorten this part of the computation we may suppose a quantity, k, such that $M\, k = m_1\, (a_1)^2 + m_2\, (a_2)^2 + m_3\, (a_3)^2 + \ldots\ldots$ and this distance, k, will be the radius of moments of inertia of the united masses $m_1\, m_2\, m_3\, m_4$. This distance is called the radius of gyration. Whence then we see that if there are a number of bodies, $m_1\, m_2\, m_3\, m_4 \ldots\ldots$ at distances $a_1\, a_2\, a_3\, a_4$ from the axis, then if the centre of gravity is distant h from the axis, and the radius of gyration is k, and the total mass of the whole is M, the angular acceleration $= \frac{M.f.h}{M.k^2} = f\, \frac{h}{k^2}$ where f is the direct acceleration estimated along the path of the particle on the various particles, which are in this case of course supposed to be subjected to the same accelerating force. In fact we have now a force acting at the centre of gravity applied to overcome an inertia located at a distance from the axis equal to the radius of gyration.

The method of computing the radius of gyration must now be considered. First let us take a uniform rod of O A of length $= a$, which rotates round O. Then, if M be the mass of the whole rod, the mass of any small piece $P P' = dx$ distant $O P = x$ from o is $M\, \frac{dx}{a}$, and the moment of inertia of that piece $= \frac{M}{a}\, x^2 dx$. Hence the moment of inertia of the whole is by integration

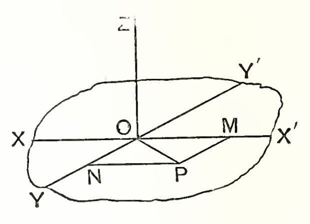
$$\frac{M}{a} \int_a^o x^2 dx = \tfrac{1}{3}\, \frac{M}{a}\, a^3 = \tfrac{1}{3}\, M\, a^2$$

and hence the radius of gyration

$$= \frac{a}{\sqrt{3}} = \cdot 57735 a.$$

If X O X', Y O Y' are two lines in a plane figure at right angles; and P a point in the plane of mass m, it is evident that the

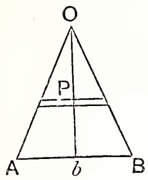
Fig. 36.



moment of inertia of P with respect to an axis O Z perpendicular to the plane $= m.\, O\, P^2$. But $m.\, O\, P^2 = m.\, P\, M^2 + m\, P\, N^2$, and $m\, P\, M^2$ is the moment of inertia of P round the axis X X' and $m\, P\, N^2$ is the moment of inertia of P round the axis Y Y'. Wherefore the moment of inertia of a particle round an axis

is always equal to the sum of the momenta of inertia round two other axes at right angles to one another and intersecting the first at right angles.

FIG. 37.



Let O A B be an isosceles triangle of mass M with perpendicular from apex $= a$, and base b, b being supposed to be very small as compared with a, and let P be an element in it distant x from O.

Then the moment of inertia of P round an axis through O perpendicular to the plane of the triangle

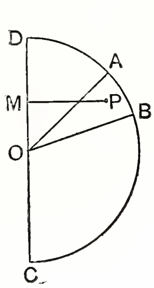
$$= x^2 \times M. \frac{\frac{b}{a}\, x.dx}{\frac{1}{2}ab} = \frac{2\,M}{a^2}\, x^3.dx.$$

Whence the moment of inertia of the whole elemental triangle

$$= \frac{2M}{a^2}\int_a^o x^3\, dx = \frac{M\, a^2}{2}$$

Whence k, the radius of gyration $= \frac{a}{\sqrt{2}}$ where b is very small.

FIG. 38.

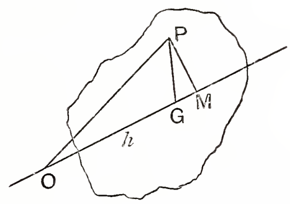


If O A B be a triangle forming an element of the circle D A B C with radius a, then the moment of inertia of the circle round an axis through O perpendicular to the plane of semicircle is obviously the sum of the moments of inertia of all the triangles, and therefore the radius of gyration of a circular disc round an axis perpendicular to its centre $= \frac{a}{\sqrt{2}}$ and therefore the moment of inertia of the disc $= \frac{Ma^2}{2}$.

Whence by the proposition previously proved, the moment of an inertia of a circular disc round a diameter $= \frac{Ma^2}{4}$ and its radius of gyration $= \frac{a}{2}$.

If we know the moment of inertia of a body round an axis passing through the centre of gravity, we can find the moment of inertia of the same body round any other axis parallel to the first. For, suppose that P is a particle of mass m, in the body of mass M, whose centre of gravity is G, and that the radius of gyration of the body round G = K. Let it be required to find the moment of inertia and k' the radius of gyration round any other axis O parallel to the first, and distant h from it.

FIG. 39.



Let the axis of rotation be taken perpendicularly to the plane of the paper, join O G, and let it be the axis of x. Let $G\ M = x_1$ and $P\ M = y_1$ then $O\ P^2 = O\ M^2 + P\ M^2 = (O\ G + G\ M)^2 + P\ M^2 = h^2 + 2\,xh_1 + x_1^2 + y_1^2$.

Whence the moment of inertia of the particle P round the axis perpendicular to the plane of the paper through O is $= m_1h^2 + 2\,m_1hx_1 + m_1x_1^2 + m_1y_1^2$. But the moment of inertia of P round the axis through G is $m_1PG^2 = m_1x_1^2 + m_1y_1^2$.

Hence the moment of inertia of P round the axis O = moment of inertia of P round the axis G $+ m_1h^2 + 2m_1hx_1$. Whence, if we sum up the whole of the movements of inertia of all the particles P round the axis O we get

$M.\ R^2 = M\ k^2 + M\ h^2 + 2\ h\ (m_1\, x_1 + m_2\, x_2 + m_3\, x_3 + \ldots.)$

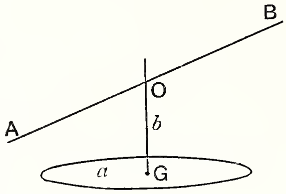
But this last series $m_1\, x_1 + m_2\, x_2 + \ldots.$ is the sum of the moments of all the small masses round the centre of gravity. Hence, by the definition of the centre of gravity it is $= o$. For it is only by this condition that the moments of the pressures would be in equilibrium. Hence, then, if R is the radius of gyration of the body round O, and h the distance of O from G the centre of gravity, and k the radius of gyration of the body round G.

$$R^2 = k^2 + h^2.$$

We can now apply this proposition to the moments of inertia already found.

For example, the moment of inertia of a disc of mass m and of radius a round an axis A B parallel to its plane and passing through a point O on a line drawn perpendicular to A B from the centre of the disc, where A O $= b$ is $\frac{ma^2}{4}$

FIG. 40.



$+ mb^2$. If the disc be considered an element in a solid cylinder of mass M, and height 2 b, having its centre at O, so that the axis A B passes transversely through its centre, then the movement of inertia of the elementary disc of mass m of radius a, at a distance of x from o, will be (mass of elementary disc) $\times \left(\frac{a^2}{4} + x^2\right)$.

$$= M\frac{dx}{2b} \times \left(\frac{a^2}{4} + x^2\right).$$

Wherefore by integration the moment of inertia of the whole cylinder round a transverse axis passing through its centre of gravity

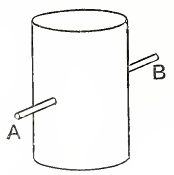
$$= \frac{M}{2b}\int_{+b}^{-b}\left(\frac{a^2}{4} + x^2\right)$$

$$= \frac{M}{2b}\cdot\frac{a^2}{4}x + \frac{M}{2b}\cdot\frac{1}{3}x^3 \text{ between limits } -b, +b,$$

$$= 2\,\frac{M}{8b}\cdot a^2 b + \frac{1}{3}\frac{M}{b}\,b^3$$

$$= M\left(\frac{a^2}{4} + \frac{b^2}{3}\right)$$ where M is the total

FIG. 41.

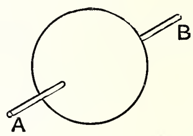


mass of the cylinder, a its radius, and $2b$ its height. This is, of course, of use in the computation of the movement of inertia of a pendulum bob. The radius of gyration, of course $= \sqrt{\frac{a^2}{4} + \frac{b^2}{3}}$. The radius of gyration of a sphere of radius a round an axis may be similarly shown to be $= \sqrt{\frac{2}{5}}\,.a$.

Hence then to sum up—

1. The radius of gyration of a rod of length a round an axis passing perpendicularly to its length round one end $= \frac{a}{\sqrt{3}} = \cdot 57735a$.

FIG. 42.



2. The radius of gyration of a disc of radius a round an axis passing perpendicularly through its centre $= \frac{a}{\sqrt{2}} = \cdot 707107a$.

3. The radius of gyration of a cylinder of radius a, and height $2b$, round an axis passing transversely through its centre $= \sqrt{\frac{a^2}{4} + \frac{b^2}{3}}$.

4. The radius of gyration of a sphere of radius a round an axis is $\sqrt{\frac{2}{5}}\,a = \cdot 63255a$.

These cases will be sufficient for most ordinary forms of pendulum bob.

For suppose we have a pendulum of length h from the centre of suspension to the centre of gravity of the bob, and the bob is spherical with radius a, and let m and M be the masses of the rod and bob respectively. Then from what has preceded, the moment of inertia of the rod $= \frac{m.\,h^2}{3}$, and that of the bob round its centre is M $\frac{2}{5}a^2$, and round the point O the total moment of inertia of the bob is M h^2 + M $\frac{3}{5}a^2$, and the moment of inertia of the whole pendulum $= m\frac{h^2}{3} + M h^2 + M\cdot\frac{2}{5}a^2$, and the radius of gyration k of the whole pendulum

$$= \frac{1}{m + M}\left(m\frac{h^2}{3} + M h^2 + M\frac{2}{5}a^2\right)$$

and for a pendulum of length h to the centre of gravity of the bob which is cylindrical, and of radius a and height $2b$, the radius of gyration round the axis

$$= \frac{1}{m + M}\left(m\frac{h^2}{3} + M h^2 + M.\frac{a^2}{4} + M\frac{b^2}{3}\right)$$

When the moment of inertia of a compound pendulum about its axis of suspension has been found, it is easy to determine its time of oscillation. For, as has been previously shown, if M is its mass, and k its radius of gyration about its axis of suspension, and h the distance of its centre of gravity from the axis of suspension, its angular acceleration

$$= \frac{M\,.\,g\,.\,h}{M\,k^2} = \frac{gh}{k^2}.$$

But if we take a simple pendulum with a rod consisting of a mere string, and a bob of a single particle of mass M but with practically no dimensions, then the distance of its centre of gravity from the axis of suspension will be equal to its radius of gyration, and its angular acceleration will be $\frac{M \cdot g \cdot l}{M\, l^2} = \frac{g}{l}$. If the length of such a simple pendulum be taken such that at every position its angular acceleration is the same as the compound pendulum given above, then the time of swing must be the same, and T which, as we have seen $\pi\sqrt{\frac{l}{g}}$ will be equal to $\pi\sqrt{\frac{k^2}{hg}}$, but, as we have seen, if k is the radius of gyration of a pendulum bob about its centre of gravity, and k' its radius of gyration about its axis of suspension, and h the distance of its centre of gravity from the axis of suspension, then

$$k'^2 = k^2 + h^2$$

whence then we have $l = \frac{k'^2}{h} = \frac{k^2 + h^2}{h}$

and $h = \frac{l}{2} + \sqrt{\frac{l^2}{4} - k^2}$. In this equation l is the length of the ordinary seconds pendulum, k is the radius of gyration of the bob and rod about their common axis of suspension. This expression for h may be shortened thus:—

$$h = \frac{l}{2} + \frac{l}{2}\sqrt{1 - \frac{4k^2}{l^2}} = \frac{l}{2} + \frac{l}{2}\left(1 - \frac{4k^2}{l^2}\right)^{\frac{1}{2}}.$$

If we expand by the binomial thereon and neglect terms after the second this becomes

$$h = l\left(- \frac{k^2}{l^2}\right) \text{ nearly} = 99{\cdot}412 - \frac{k^2}{99{\cdot}412} \text{ nearly},$$

l being the length of the simple seconds pendulum in centimetres.

Suppose that the bob is a cylinder of 4 c. radius and 8 c. high, and that the rod is so thin that we may neglect its weight and inertia,

$$\text{then } k^2 = \frac{(4)^2}{4} + \frac{(4)^2}{3} = 9{\cdot}\dot{3}.$$

whence $h = 99{\cdot}3185$ c., showing that such a pendulum, in order to beat seconds, must have its centre of gravity put ·093 c. above the lower end of a corresponding simple seconds pendulum. In very careful computations, the moment of inertia and centre of gravity of the rod ought also to be taken into consideration in the computation of k.

This consideration alters the formula for finding T, which then becomes $T = \pi\sqrt{\frac{L}{g}}$

$$= \pi\sqrt{\frac{\text{moment of inertia round the axis of suspension}}{\text{moment of forces round the axis of suspension}}}$$

If the moment of inertia of the bob round its centre of gravity is $M\,k^2$ then the moment of inertia of the bob round the axis of suspension $= M\,(h^2 + k^2)$ where h is the distance of the C. of G of the bob from the axis of suspension. The moment of inertia of the rod $= m\,\frac{(h - b)^2}{3}$ where b is $\frac{1}{2}$ the height of the bob. For that part of the rod which is inside the bob may be neglected if in taking the moment of inertia of the bob we neglect the hole in the centre and treat it as a solid. The statical moment of forces on the bob $= Mh$, and that on the rod $= m\frac{h - b}{2}$. Then taking $g = 981{\cdot}166$, and $T = 1$ second and $\pi^2 = 9{\cdot}8696$, we shall have

$$981{\cdot}1\left(M\,h + m\,\frac{(h - b)}{1}\right) =$$

$$9{\cdot}8696\left(M\,(h^2 + k^2) + m\,\frac{(h - b)^2}{3}\right)$$

In this equation all the quantities except h are known from measurement, so that h may be found without difficulty. Its value depends of course on the moment of inertia of the bob, and the weight and size of the rod. If the rod is small the tendency is for h to have only a slightly smaller value than l, the length of the simple seconds pendulum, but if the rod is thick and big then naturally h is somewhat shortened. It usually works out about one or two millimetres shorter than the value of l. It is therefore not necessary to make special allowance for it in practice. For in that case l is near enough to use as a factor for calculating the temperature compensators, and in all pendulums the exact regulation of the length of the pendulum is always done by trial.

The adjustment of the time of swing of the pendulum is usually accomplished in one of two ways—either by adjusting its length till it keeps proper time, or else by weighting it.

The first of these methods is usually effected by a screw of some sort. In such an arrangement it is of importance that the nut and screw should be made of the same metal. For the defect of a nut is that you never know on what point of it the screw really rests and presses. So that if you have a brass nut working on an iron screw, alterations of temperature may produce unknown alterations of length, and every time the nut is touched a new point of support is reached and new temperature conditions introduced.

If, however, a nut and screw of the same metal are employed, and a lock nut provided, a screw is as good a means of support for the pendulum bob, as a pin, or any other method; and possesses in addition the advantage of

being adjustable. If the screw have 36 threads to the inch, a complete turn of the nut will very nearly make an alteration of $\frac{1}{2}$ minute a day in the time, so that if the nut be divided into 30 divisions on the rim, each division turned through will alter the time one second in a day.

A pin, however, is a good method, if a washer of hard material be put upon it. For by altering the thickness of the washer any desired position can be given to the bob.

The amount necessary to shorten a pendulum in order to make a given alteration in the time of the clock is easily calculated. For if l be the length of pendulum corresponding to the period of single oscillation t, then $t = \pi\sqrt{\frac{g}{l}}$. (1).

Now suppose that an amount, $\mu\, t$ is added to t, and a corresponding $\nu\, l$ is added to l.

$$\text{Then}\quad t(1+\mu) = \pi\sqrt{\frac{l(1+\nu)}{g}}. \quad (2).$$

Square (2) and subtract (1) from (2) then

$$2\mu t^2 + \mu^2 t^2 = \pi^2 \frac{\nu l}{g}.$$

If μ is small, compared to t, as for instance one second in a day, we may neglect $\mu^2 t^2$.

In this case $2\mu t^2 = \frac{\pi^2 \nu}{g} l$. Whence $2\mu = \nu$.

This shows us that the proportion to be added to t is one half that to be added to l. In other words, in order to make a small difference in the time, we must make double of that proportional difference in the length of the pendulum. If the pendulum is 99·4037 cm. in length, then to make a difference of 1 second a day, or 1 in 86400, we must add to the pendulum $\frac{2}{86400}$ of its length, or $\frac{2 \times 99{\cdot}4037\ \bar{c}.}{86400}$ $= 0{\cdot}023\ \bar{c}$. or not quite $\frac{1}{1000}$ inch.

Another method of altering the time of swing is by adding weights to the centre of the rod.

As we have seen

$$t = \pi\sqrt{\frac{\text{moment of inertia of the system.}}{\text{moment of forces on the system.}}}$$

$$= \pi\sqrt{\frac{\mathrm{M}\,k^2}{\mathrm{M}\,gh}}$$

If, then, on a pendulum consisting of a particle of mass M distant h from the point of suspension, and whose radius of gyration is k, we place a small weight m at a distance d from the point of support, the time of swing will be shortened.

Let μ be the proportion of shortening of the time, then

$$t(1-\mu) = \pi\sqrt{\frac{\mathrm{M}\,h^2 + md^2}{g \times (\mathrm{M}\,h + m\,d)}} \quad (1) ;$$

$$\text{but } t = \pi\sqrt{\frac{h}{g}}. \quad (2).$$

$$\text{whence } 1 - \mu = \sqrt{\frac{1 + \frac{m}{\mathrm{M}}\cdot\frac{d^2}{h^2}}{1 + \frac{m}{\mathrm{M}}\cdot\frac{d}{h}}}$$

square both sides and neglect μ^2 as too small to be reckoned and you have

$$2\,\mu = 1 - \frac{1 + \frac{m}{\mathrm{M}}\cdot\frac{d^2}{h^2}}{1 + \frac{m}{\mathrm{M}}\cdot\frac{d}{h}}$$

But if m be very small as compared with **M**, we may neglect the term containing it in the denominator as it will not be large compared with 1. Whence $\mu = \frac{m}{2\,\mathrm{M}}\left(\frac{d}{h} - \frac{d^2}{h^2}\right)$ nearly. If the weight m be put in the middle of the rod so that $d = \frac{1}{2}\,h$ then $\mu = \frac{m}{8\mathrm{M}}$, and if μ be a second in a day, then $\mu = \frac{1}{86400}$ and $\frac{m}{\mathrm{M}} = \frac{1}{10800}$ thus showing that a gramme weight put in the centre of the rod will accelerate by a second a day a pendulum weighing 10·8 kilogrammes = $23\frac{1}{2}$ lbs.; other weights may be calculated easily from this formula.

It has been shown that a small variation of about $\frac{1}{1000}''$ in length, or more exactly ·0023 $\bar{c}$, produces a difference of time of 1 sec. a day in a pendulum's time of vibration. This renders it obvious that temperature will affect the time of a clock. For since the linear coefficient of expansion of iron is about ·000012 for each degree Centigrade of increase of temperature it is clear that a pendulum rod of 100 c length at the freezing point of water, will on a hot summer day, at 25° C, become ·0300 $\bar{c}$ longer, and thus cause the clock to lose about 13 seconds a day. Moreover, the expansion of the bob will cause other alterations, and the change in the temperature of the surrounding air will alter its buoyancy, and also affect the time.

And, lastly, changes of barometric pressure will also have an influence.

All these must be considered in order.

The first and largest is the effect of changes of temperature on the rod.

Increase of temperature by lengthening the rod of the pendulum makes the pendulum go slower. It is necessary therefore to compensate it. A number of plans for compensating pendulum rods have been invented. But we shall here deal only with—

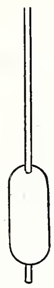
(*a*). The wood and lead pendulum.

(*b*). The mercurial bob pendulum.

(*c*). The mercurial tube pendulum.

(d). The gridiron pendulum.
(e). The zinc tube pendulum.
(f). The lever pendulum.
(g.) Invar.

Fig. 43.



(a). Pendulums with a rod of wood answer well if the wood be perfectly dry and saturated (preferably under the air pump) with paraffin wax or else thoroughly soaked in spirits of wine to which subsequently some shellac is added so as to penetrate the pores of the wood and keep the damp from affecting it. The expansion of wood is about ·00000432 per 1° C. That of lead is ·0000298 per 1° C, thus if L be the length of the rod down to the centre of gravity of the bob, and $2\,b$ be the height of the bob, then $b \times .0000298 = (L + b) \times {\cdot}00000432$; but $L = 99{\cdot}3185\ \bar{c}$. Whence $23 = 33{\cdot}63\ \bar{c}. = 13\frac{1}{4}$ inches. Wooden rods are in considerable use, especially for turret clocks.

The mercurial pendulum consists of a jar of glass or steel about 2″ in diameter hung from a steel rod, either by a strap, or else in some equivalent manner. The use of steel is preferable to glass as it is stronger.

Glass has some advantages because its coefficient of expansion is small, and thus the mercury column need not be so high as in the case of steel.

The compensation of the mercurial pendulum is a somewhat complicated matter, for account has to be taken of the expansion of the vessel in which the mercury is placed. If a_1 is the linear coefficient of expansion of the steel rod and strap, a_2 the linear coefficient of expansion of glass, and a_3 the (linear) coefficient of expansion of mercury. Then, if $2\ \gamma$ be the internal radius of the jar, V the volume of the mercury, and h the height of the mercury in the jar, at standard temperature, $V = \pi\,\gamma^2\,h$. (1) But after a rise of temperature of 1° C.

$$V\ (1 + a_3)^3 = \pi\,\gamma^2\ (1 + a_2)^2\ (1 + \mu)\ h \quad (2)$$

where μ is the proportion by which the height of the mercury has risen, so that $(1 + \mu)\,h$ is the new height, whence eliminating between (1) and (2) we have

$$\mu = \frac{(1 + a_3)^3}{(1 + a_2)^2} - 1 = \frac{1 + 3\,a_3}{1 + 2\,a_2} - 1 \text{ (nearly).}$$

The usual values are $a_3 = {\cdot}000054$, and $a_2 = {\cdot}00000864$ and $a_1 = {\cdot}00001152$, whence $\mu = {\cdot}000142$. This shows us that for each degree Centigrade h increases by an amount $= h \times {\cdot}000142$. Now for each 1° C. the rod expands by an amount $= 99{\cdot}3185.a_1$, whence, if $2\ b$ be the height of the mercury $(99{\cdot}3185 + b)\ a_1 = b\ \mu$. From which we have $2\ b$, the height of the mercury in the glass $= 17{\cdot}517\ \bar{c}$
$= 6{\cdot}88$ inches.

The heights of mercury in the glass necessary to compensate a steel rod as given in the books vary considerably. The usual cause of this is that the expansion of mercury as given by various authors varies. I have taken a determination made for the Royal Society—viz., $a = {\cdot}000054$ (linear) per 1° C, which is probably the most correct.* Mercury is often contained in an iron or steel bottle. The rod is fixed to a stopper, which is screwed into the bottle. This is a convenient arrangement. It is less fragile than glass, and the rod dipping into the mercury has a tendency to share its temperature. In the above calculation the expansion of steel or iron must be substituted for that of glass to get a correct result. The steel bottle must, of course, not be brazed, or the mercury would soon attack the solder. It is better to coat the inside of the bottle with paint. The outside may be dull blackened to facilitate the radiation of heat and keep the bob at the same temperature as the rod.

In this case the figures would be $a_1 = {\cdot}00001152$ for the rod $a_2 = {\cdot}00001152$ for the vessel, and $x_3 = {\cdot}000054{\cdot}$ for the mercury,

$$\text{whence } \mu = \frac{1{\cdot}000162}{1{\cdot}00002304} - 1 = {\cdot}0001385.$$

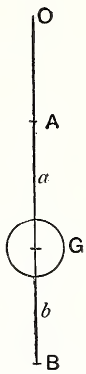
$$\text{and } 2b = \frac{2 \times 99{\cdot}3185}{\mu - x_1} = 18{\cdot}0118\ \overline{cm.}$$
$$= 7{\cdot}092.\ \text{inches.}$$

The mercury and steel pendulum has long enjoyed a deserved popularity. Its great defect is that it is slow to compensate changes of temperature. For if a mercury pendulum with a receptacle made of iron is suddenly

* A very elaborate examination of this subject was made by Baily in 1823. See Memoirs of the Astronomical Society, vol i., p. 381. He places the height of the mercury in a glass vessel at 6 3-10th inches. This is, however, very small. The usual height given in practice is 6·8 inches for a glass vessel and 7 inches for an iron one.

heated on the outside, instead of expanding upwards, the mercury will at first descend, and thus instead of compensating the rod will actually add to its error. This of course is due to the expansion of the case and not for some time will the heat reach the mercury. To avoid this Mr. Nelson proposed to use a group of tubes of mercury. But this would render the air compensations difficult to calculate. The considerations given above, however, show that mercury pendulums should preferably be enclosed in iron cases which conduct heat more readily than glass and that they should not be made too big.

Fig. 44.



(*c*). Another form of mercury pendulum has been proposed by Reifler. The rod is made of a steel tube, projecting some distance below the bob and filled with mercury up to a certain height, which may be half way between the centre of the bob and the suspension. It is then obvious that as the heat expands the rod and lowers the bob, and thus retards the pendulum, that the mercury in the tube expands and carries a weight up to its surface, which, in accordance with the formula given above, accelerates the pendulum; and the sizes of bob and rod can be so adjusted that these results balance one another.

In the *English Mechanic*, August 23rd, 1907, the dimensions of a Reifler pendulum are given by Mr. Granger. From O to A, the surface of the mercury, the distance is 53·9 $\bar{c}$. From A to B, the bottom of the steel tube, the distance is 71·12 $\bar{c}$. The bob is of brass, and lenticular, and weighs 2·954 grammes. There is a large adjusting nut at the end of the tube, which weighs 257 grammes. The whole pendulum weighs 5·882 kilos.

The expansion by heat of the steel rod, carrying the bob is ·0000115 × 100 $\bar{c}$ per 1° C. of temperature, which, as we have seen, causes a retardation of ·5 secs. a day.

This, however, is compensated by the expansion of the mercury in the tube. If the clock be retarded ·5 secs. a day, the amount of mercury which it is necessary to add at A will be m.

$$\text{Where } \cdot 5 = \frac{m \times 86400}{2 \times M}\left(\frac{OA}{100} - \frac{OA^2}{100^2}\right)$$

$$\text{Whence } m = \frac{5\cdot 882}{21\cdot 6} \text{ grammes.} \quad (1).$$

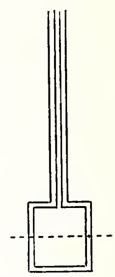
But 1° C. of temperature will expand the mercury in the tube by a vertical linear amount $= \cdot 00014 \times 71\cdot 12\ \bar{c}$ so that it will add at A a weight of mercury $m = \pi \times \frac{d^2}{4} \times 13\cdot 6 \times \cdot 00014 \times 71\cdot 12$ grammes. (2) where d is the internal diameter of the tube.

From these two equations we have $d = 1\cdot 564\ \bar{c}$ or about $\frac{5}{8}$ inches. The above calculation is of course approximate only, but sufficiently near for practical purposes. The final adjustment of compensation is made by means of the nut.

Various different diameters and dimensions can thus be calculated.

The advantage of this shape of mercurial pendulum is that the mercury is well exposed to the action of changes of temperature, and thus changes rapidly with the changes of the rod.

Fig. 45.

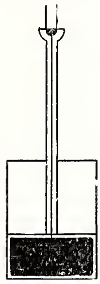


In this calculation no allowance has been made for the distance of the centre of oscillation from the centre of gravity, nor is it necessary.

(*b*) I should think, however, that a better form for this pendulum, and certainly an easier one to calculate, would be that devised by Troughton in the eighteenth century, consisting of a flat drum of glass or iron at the centre of the bob which should be made annular. This would readily take up any changes of temperature, and give a good rise of mercury at the central point of the steel tube forming the rod. (Fig. 46).

A pendulum might be made to consist of a steel bottle, into which a tube for the rod is screwed and the whole filled with mercury up to a point halfway up the rod and let the whole have a mass M.

FIG. 46.



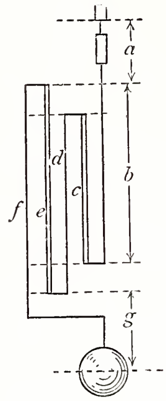
Then each degree C of temperature will lower the C of G by 99·3185 × 00001152. This will lengthen the time of swing by $\frac{99·3185 \times ·00001152}{·0023} = ·4858$ second per diem.

To compensate this we must put a weight, *m*, at a distance = 49·659 from the point of suspension, such that $\frac{m}{M} = \frac{·4858}{10·800}$ or $m =$ M × ·000044·982, that is ·045 of a grain for every kilogramme weight of the bob.

If the mercury is enclosed in a steel receptacle, then the coefficient of expansion of the mercury will be ·00014 per 1° C, so that in order to drive out of such a vessel a weight of mercury of ·045 grains, by a rise of 1° C. the cubical content of it must = 23 cubic centimetres. Whence then for every kilogrammes of total weight of the bob, we must have 23 cubic centimetres of mercury, enclosed in an iron vessel. From this a steel tube of small bore, which may be the rod of the pendulum, leads up to a small chamber placed midway on the rod, and into which the excess of mercury can be forced, and by its weight compensate the retardation due to the heat-expansion of the rod. Such a pendulum could be made of an iron drum C with interior height about ¼ of those of the lead top. From this would lead the pendulum rod made of iron tube of say one or two millimetres internal diameter, and with a small chamber A, distant 49·7 centimetres from the point of suspension. On the drum could rest a cylindrical weight. The chamber should have its bottom firmly screwed on by screws that should go right through the mercury and keep the box from bulging.

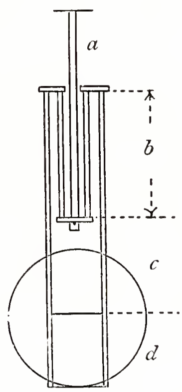
(*d*.) The gridiron pendulum consists of a number of steel and brass rods placed side by side. These are joined together so that the steel and brass rods are in pairs. In attaching them to the cross frames care must be taken to pin the rods well and firmly on the

FIG. 47.



frames with steel pins so that there is no back lash. Cross bars must be provided so that the brass rods which are in compression do not bend, which would of course be fatal to accuracy.

FIG. 48.



It is evident from the figure that if the single lines are made of steel and the doubled ones of brass that if—

$a_1 =$ ·00001152 (steel)

$a_2 =$ ·00001800 (brass).

Then $(a + b + d + f + g)a_1 = (c + e)(a_2)$,

and $a + f + g = 99·3185$.

$\therefore (99·3185 + b + d)\, a_1 = (c + e)\, a_2$

If the horizontal connecting rods are 1 c. apart, then $b = d$ and $c + 2 = l$, and $c + 1 = d$.

Whence we shall have

$a = 3·128$ c, $g = 8$ c, and $e = 87·21$ c.

These dimensions just allow of the bob and suspension being fixed in their proper places.

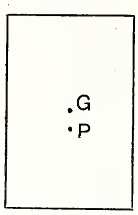
I have assumed that the bob is suspended from its centre. If it be suspended on its lower end, and be of brass or lead, then a further allowance should be made for the expansion of the bob. These pendulums are very trustworthy. The only drawback is that the rods must be strong to bear a heavy pendulum, and that this necessity for strength makes them heavy. Hence a substantial correction is needful for the large moment of inertia of the rods.

This can easily be done by taking the above sizes, calculating the moment of inertia, thus obtaining a new value for h, and then working the figures out again with the new (and slightly larger) values substituted for the old one of 99·3185, which is the value of h for a pendulum with an average moment of inertia.

In making pendulums with rods of metal, it is an excellent thing to "age" this metal by giving it some 10 or 20 heatings in hot water, say to 100° Fahr. (36°C.) or so, and then allowing it gently to cool. By these repeated annealings the uniformity of expansion of the rod is greatly promoted. Absolutely pure copper, hard drawn and then gently annealed, is an excellent material for making a gridiron pendulum.

(e). The zinc and steel pendulum consists of a rod of steel terminated at its lower end by a

FIG. 49.



washer. On this rests a tube of rolled or drawn zinc (cast zinc is too soft), which supports a washer from which is hung an iron tube that supports the pendulum.

From the figure it is evident that if α = ·0000115·2 be the linear coefficient of expansion of steel, and β = ·0000288 be that of zinc, then

$$(a + b + b + c + d)\,\alpha = b\,\beta.$$

$b \times \cdot 00002304 + (a + c + d)\,(\cdot 00001152) = b\,(\cdot 0000288)$.

Let us suppose that $d = 7$ centimetres, then $a + b + c = 99{\cdot}3185$ cm. Whence $b = 70{\cdot}879\ \bar{c} = 28$ inches nearly.

As soon, however, as this result is found it will be necessary to take the dimensions of the tubes of zinc and iron, calculate the difference that their weight makes in the radius of gyration, and hence find the proper radius of oscillation, and then work the sum over again, by which means a slight reduction in the above-found length of 28 inches will be produced. In practice, for reasons depending on air density, more than an inch will have to be taken off this zinc tube; but the consideration of this correction will be discussed presently. As the zinc is liable to be crushed with the weight of a heavy bob, it is a good plan to put a spring on the rod to press upward on the bob, as suggested by Ellicott in the eighteenth century. For this purpose I prefer a helical spring, which may be embedded in a cylindrical hole in the pendulum. The spring should be adjusted so as only to take $\frac{1}{2}$ to $\frac{1}{3}$rd of the weight of the bob, and thus keep the contacts tight up to their work.

(f). Another method of compensating pendulums is due to the French, and was developed by Ellicott. It consists in causing the unequal expansion of the rods to move a lever, which raises the centre of oscillation of the bob. Thus, if the central rod expands and lets down the back ends of the levers, then a smaller expansion of the side rods will let down the centres of the levers to a less degree, and thus raise the points on which the bob rests, and thus, if the parts are properly apportioned, the bob may remain at rest, notwithstanding the heat expansion. As the strain on the levers is considerable, Ellicott proposed to put a strong spring under the bob, so as to take its weight off. Lord Grimthorpe, in his work, makes merry with the supposed defects of this plan, which he has clearly never tried, and I should say probably has not appreciated. A more modern form of this pendulum may be suggested. It consists of a rod of steel and a tube of brass. The spring is helical and imbedded in the pendulum bob.

(g). A great step forward was made a few years ago, in the construction of pendulums, by the invention by Dr. Guillaume, of Paris, of the metal "invar." This remarkable substance is an alloy of steel and nickel in the proportion of about 25 per cent. of nickel. As a result a metal is obtained that has a coefficient of expansion from ten to twenty times smaller than that of ordinary steel.

The use of such an alloy is obvious, for the problem of compensation becomes very easy. For instance, with a metal which expands ·0000004 for each 1° C. a small gridiron about two inches long suffices for compensation. Or

else the compensator can be placed in the bob itself.

Experiments have been made to see whether invar loses its qualities when subjected to tension. It is, however, found to stand remarkably well. It changes its coefficient slightly through age, and it should be artificially aged by heating a few times in hot water and allowing it to cool.

Invar is made of various degrees of expansibility. A very convenient coefficient is ·000003, because if with this coefficient a bob be taken made of lead hardened with antimony, and 8 inches high, resting on its lower end, the expansion upwards of the half-bob, will just correct the expansion downwards of the invar rod, and at the same time make the allowance for air density that will be presently explained.

The only drawback is that the bob being thick expands more slowly than the rod. Hence it would be preferable to hang the bob from its centre.

Instead, however, of using the expansion of the bob as compensator, it is better to employ a brass or copper tube, placed either outside or inside the bob, as is explained in greater detail hereafter.

(To be continued.)

RAILWAYS IN CHINA.

A careful and interesting *résumé* of information regarding railways in China will be found in the bulletin of the "Société de Géographie Commerciale de Paris," from the pen of M. de Lapeyrière, assistant engineer of the Shansi railways. The article is sub-divided into four categories or sections, viz. (*a*) lines open, (*b*) lines under construction, (*c*) the construction of which on principle has already been decided on, and (*d*) lines in contemplation or projected.

(*a*) Railways Open.

In this category enter the following :—

1. Peking-Tientsin-Shan-hai-kwan and New-chwang line, 450 miles long. With the exception of the short branch line from Wu-sung to Shanghai, which was demolished in 1878 and rebuilt in 1898, this railway is the oldest in China and originated out of a small undertaking constructed in 1892 for conveying coal and materials to and from the well-known Kaiping collieries, Tong-kew, at the north-west angle of the Gulf of Pechili, and Tientsin; continuations north-westward to Peking and north-eastward to New-chwang and Manchuria have since been made. At Kao-pang-tze a branch leads towards Mukden, and has already been completed as far as Sinminting: the remaining 60 kilometres, or 37 miles, will establish a continuous line between Peking and Mukden. Another small branch, $15\frac{1}{2}$ miles in length, between Peking and Tung-Chow on the Pei-ho, will raise the total mileage to nearly 540 miles. The working of the line is in the hands of a mixed British and Chinese administration.

2. Peking-Hankow or Great Central Chinese line.—This line has been constructed by the Imperial Chinese Railways Company, and is commonly called the Lu han railway. The northern terminus is a few hundreds of yards distant from that of the Peking-Tientsin line, communication between the two being effected by a branch from Feng-tai to Lu-ku-kiao. The line was officially opened in November, 1905, after the completion of the great bridge across the Yellow River, a structure not far short of two miles in length. This important line is nearly 750 miles in extent; its construction was not very difficult except in respect of bridging, the rivers crossed being numerous and important. The working gives good results and there is considerable traffic in grain and coal. There is a daily passenger train each way between Peking and Hankow, the whole journey being effected in three days. The first evening's stop is made at Chan-te-fu, 316 miles, and the second at Chu-ma-tien, 563 miles from Peking, the Chinese being apparently as averse to travelling by night in trains as they are in ships. There is also a daily passenger train between Peking and Chem-kia-chwang, the rail-head for Shansi, and once a week there is a train composed of wagonettes, first and second-class, with wagon restaurant, which covers the distance in 36 hours; the cars are very comfortable and the service regular. Between Peking and Hankow there are numerous freight trains and the goods traffic gives evidence of prosperous development.

3. The Shantung or Tsin-tau—Tsi-nan-fu line. Since the German occupation of Kiaochow in 1898 various lines have been started in Shantung, the chief of these uniting the port with the provincial capital; it is 271 miles in length, passes through a hilly country and taps some important collieries; it will also be connected with the great north and south line, which an Anglo-German syndicate is to construct from Tian-tais to the Yangtze river.

4. The Tao-kow—Ching-huan (Honan) line, a concession for which was granted to the Peking Syndicate for exploiting coal mines, was constructed in 1902-04. It has since been taken over by the Imperial Chinese Railway Company, but continues to be worked by the Peking Syndicate. It cuts the Peking-Hankow lines at Wei-wei-fu for 568 miles from the former city. It is about 93 miles in length.

5. The Shanghai-Wu-sung line, a little over nine miles, connects the great port with the mouth of its river, where the great liners anchor. It was originally constructed in 1876, was demolished in 1878, and reconstructed in 1898. The concession is held by the British and Chinese Corporation.

The total mileage of these railways, already opened,

is only 1,728 miles, branches included, but it must be borne in mind that practically they date only from 1898.

(b) Lines under Construction.

1. Peking-Kalgan.—This line, which is believed to be the precursor of the Trans-Mongolian line, was begun in 1905. About 30 miles of it is already open, and 92 more are to be laid down. It was constructed with Chinese capital out of the profits of the Peking—Shan-hai-kwan line and the terminus is at Nan-kow, near the outer spurs of the Mongolian plateau. Its administration and engineers are Chinese, and it is intended to be the prototype in point of organisation of all other lines in contemplation.

2. Shansi line from Chen-kia-chwang to Tai-yen-fu.—The concession for this was granted under similar conditions to those of the Peking-Hankow line. It is on the metre gauge, about 150 miles long, and is intended to develop the mineral resources of Shansi, which the late Baron F. von Richthofen described as being sufficiently rich to form a reserve for the whole world's consumption. The line was begun in 1904 and was to have been completed in October last, but the mountainous character of the country has interposed difficulties and delay. There are 18 tunnels and 12 iron bridges. The line will serve as an important feeder to the Peking-Hankow line, which it joins at Che-kia-chwang, 173 miles from Peking.

3. Kai-fong-fu to Ho-nan-fu. This line runs parallel to the Yellow River and about 93 miles of it passes through the yellow *loess* country.

4. Shanghai to Nanking.—This is an interesting line, about 180 miles in length, and passes through a highly fertile and populous rice and silk country between the two important cities which form its termini. Soo-chow, a famous place in the Tai-ping rebellion, and centre of the silk trade, lies about halfway. The railway is nearly complete.*

5. Kiangsi line, Kinkiang to Nan-chang.—This, like the Peking-Kalgan line, is being constructed with Chinese capital and Chinese *personnel*, and a good deal of interest attaches to the enterprise as a national and administrative experiment. The length is 81 miles.

6. Canton to Kow-loon.—An English syndicate hold this concession, the object being to unite the port of Hong-Kong with the great commercial centre of Southern China.

7. Swatow to Chow-Chaow.—A Chino-Japanese undertaking. About 32 miles long.

8. Lao-kai to Yunnan-sen.—This concession was made to the French Government in 1898, and the railway (metre gauge) has been under construction since 1902, but there are great physical difficulties between the valley of the Red River and the Mong-tze plateau, a little under 4,600 feet in height. Eighty to ninety bridges, and numerous tunnels have to be constructed. In spite, however, of the unhealthiness of the climate, it is expected that the entire line, 281 miles in length, will be completed in 1910.

The aggregate length of these lines, under construction, amounts to 1,087 miles.

* Opened on the 28th March last.

(c.) Lines of which the Construction has been decided on in Principle.

1. Tientsin to Chinkiang.—Concession granted to an Anglo-German Syndicate will run fairly parallel to the course of the Grand Canal. Length, including two branches, about 912 miles.

2. Tai-yuen-fu to Sin-ngan-fu, uniting the capitals of Shansi and Shensi, traversing the former province from north to south, and forming the continuation of the Chen-kia-chwang—Tai-yuen-fu line. About 310 miles.

3. Canton to Hankow. — Concession originally granted to American syndicate and bought back by the Chinese Government. The Americans had actually constructed about 23 miles, but the plans are being re considered by Japanese engineers and nothing further has yet been done. It will probably pass through Yo-chow, and near the Tung-ting lake, and through Chang-sha, Hong-chow, Chao-chow, Sam-chin, and Canton. Length about 600 miles.

4. Foo-chow to Amoy.—About 175 miles.

5. Lien-chow to Kwang-cheow-nan.—About 75 miles.

6. Hankow to Sz-chuen.—This project is engaging the earnest attention of the viceroys of Sz-chuen and Hupeh, but many years must elapse before it can assume definite shape. Its most likely course will be to diverge from the Hankow-Canton line south of the Tung-ting lake, and thence trend westward towards Chung-king and Sz chuen. A branch 200 miles long would connect with Kwei-yan for the capital of Kwei-chow. The main line would be over 800 miles.

7. Yunnan-sen, Sui-fu, Cheng-tu.—Is occupying the careful attention of the promoters of the Tonking-Yunnan line, who hope to attract towards the port of Haiphung the products of the rich province of Sz-chuen—silk, cotton and minerals—and its 60,000,000 of inhabitants. There appears to be no doubt that the line is quite feasible but it would take time. Its length would be about 530 miles and would thus connect the capital of Sz-chuen with the sea, at a distance of rather more than a thousand miles. The total mileage of this group would be about 3,618 miles.

(d) Lines in Contemplation or under Consideration.

1. Tai-yen-fu to Tatung-fu.—This line is called for by bankers and merchants of Shansi who have applied for permission to build it; it would traverse all the northern part of Shansi, which is lacking in means of communication. Length about 187 miles.

2. Honan-fu to Sin-ngan-fu.—Has been applied for by the financiers who are constructing the Kai-fong—Honan-fu line. It would follow part of the course of the Yellow River and dispose of the trade of an

important area of Central China. Length about 318 miles.

3. Sin-ngan-fu to Lan-chow.—Would penetrate furthest into the heart of China and open up its most distant and secluded province, Kansu. Very difficult to construct, the height in some places being 6,000 feet. Length about 430 miles.

4. Sin-ngan-fu to Cheng-tu-fu.—Would form the last section required to unite the capital of Sz-chuen with Peking. A difficult line, 360 miles long.

5. Sin-yang to Chin-kiang.—Would tap a rich cereal region. Length 310 miles.

6. Soo-chow, Hang-chow, and Ning-po.—Concession promised to British and Chinese Corporation. Rather under 170 miles.

7. Nan-chang to Chang-sha.—Projected by the notables of Kiangsi, and will form a logical link between the Kiu-kiang—Newchang and Han-kow—Canton line. Length 200 miles.

8. From the Tong-king frontier to Nanning-fu, Oo-chow and Canton.—The first section of this line was planned out in 1897, but has never got any further. Length, including two branches at Pakhoi and Kwei-lin, about 690 miles. Total length of the group 2,575 miles.

Speaking generally, Mr. Lapeyrière thinks that the above projects could be all carried out in 15 to 20 years, though, of course, there are important considerations, such as the particular demands which the provincial Governments may make on the Central Government which may profoundly affect the situation. There may, too, be a tendency towards homogeneity in the whole system, and probably two gauges may come to be adopted, according to the nature of the ground, viz., the metric gauge and 1·45 m. gauge.

SUMMARY.

(*a*) Lines already open	1,728 miles
(*b*) Under construction	1,087 ,,
(*c*) Sanctioned................	3,618 ,,
(*d*) Projected	2,575 ,,
Total........	9,008 miles.

M. Lapeyrière remarks that compared with the vast population of the Chinese Empire, the above total is quite insignificant, and is sure to be largely exceeded at no distant date. He states also his willingness to contribute any other information in his power on a topic of such widespread interest.

THE ITALIAN BEET-SUGAR INDUSTRY.

All the sugar produced in Italy is refined from the sugar-beet. No cane-sugar is produced, and therefore a small quantity is imported to meet a special demand, the imports in 1906 amounting to only 12,412 tons, the largest import since 1902, when it amounted to 20,011 tons. Austria supplied more than one half the total imports in 1906, France, Belgium, and the United Kingdom following in the order named. The 100,000 acres under sugar cultivation in Italy were formerly almost waste ground, with the exception of a small amount of fruit grown thereon. To-day this ground yields from £8 to £12 worth of beets per acre. Formerly the fruit grown on the ground brought from £5 to £8 per acre. This increase means a great deal to Italian agriculture in general. It raised the wages paid for farm labour a little over one penny per acre, and gives employment to large numbers of factory hands at from two shillings and sixpence, to four shillings and sixpence per day. According to the United States Consul at Milan, there are at present about 26,000 persons employed in the sugar industry in Italy. The by-products are used to good advantage, mostly for feeding animals. The price of these by-products is about one shilling and tenpence per ton. To produce the Italian sugar output it is necessary to use 1,100,000 tons of beets, and these yield enough by-products to feed 30,000 cattle. It is also stated that the waste of the refinery process is commencing to be used as a fertilizer. In many other ways the industry has been useful. The molasses waste of the beet in Italy is not manufactured, on account of the high cost of that process, but is sold in the open market for the distillation of alcohol. It takes 9·54 tons of sugar-beets to produce one ton of sugar. The Italian refinery must pay the cultivator an average price of nineteen shillings per ton of beets, including transport expenses from the field to the refinery. Therefore over £9 must be spent for beets to make one ton of sugar. The cost of manufacture, excluding interest on capital, amounts to about £4 per ton of sugar. After refining expenses are paid, excluding interest on capital, a ton of sugar costs in Italy about £13, or nearly three half-pence a pound, not including the Government tax on production. The various sugar-beets, cultivated at present in Italy, are grown from selected imported seeds, although results obtained are not entirely satisfactory. Italy stands in great need of native seed. Italy imports annually seed of all kinds to the value of about £730,000. It often happens that the imported seed is of inferior quality. The Italian demand for seed can not at all times be supplied by foreign seed exporters, and in such cases the seed is collected immature and sent in that condition to Italy. The "Unione Zaccheri," with main offices in Milan, is an organization of Italian refineries to control production. The union establishes the quantity of sugar that each refinery may produce in any given year. Every Italian refinery, except one, is a member of the union. There are thirty-four refineries in Italy to-day, and the construction of the thirty-fifth was started about six months ago. The union determines the selling price of sugar in Italy, which has always to be lower than that for which imported sugar could be sold. The union is believed in Italy to be of the greatest assistance to the success of the sugar industry. It does not speculate, nor can it create special and abnormal prices, on the Italian market. By its aid it is next to impossible to

turn out an over-production, such as, happening often, would mean the ruin of the industry. There is about £4,900,000 invested in this industry in Italy at the present time.

THE DEPOPULATION OF IRELAND.*

From 1801 to 1846 the population of Ireland steadily increased, while from 1847 to the present time it has just as steadily diminished. The year of the great famine marks a dividing line in Irish history. Before 1846 the agriculture of this country was largely of the tillage order, while since that date it has assumed the pastoral form.

The dominant influence in Irish industrial history for the early forty-five years of the nineteenth century was Foster's Corn Law. It is not, perhaps, an over-statement to say that no Act so profoundly modified our history as the far-reaching measure brought forward by Foster in 1784. Its author modelled it on the English Corn Laws as they had existed since 1688. The change from pasturage to tillage came at a time when it proved peculiarly suitable to the requirements of England, where the industrial revolution was making rapid strides. Consequently the demand across the Channel for corn enormously increased, and the supply came largely from Ireland. With the rise in the price of corn came the inevitable influence in the marriage rate. In 1811 the population was 5,956,466; in 1821 it was 6,801,827; in 1831 it was 7,767,401: in 1841 it was 8,199,853; and in 1845 it was 8,295,061.

With the fall of prices consequent upon the conclusion of the Napoleonic wars the hard years began to come. The tide of emigration flowed in 1826 and 1827, for the landlord attempted to consolidate the small holdings. The development of transport coincided with the opening of the Mississippi valley, and these changes promoted the growth of free trade in England. What gravely affected Ireland since 1846 was not the potato famine, but the abolition of the Corn Laws. A student of eighteenth-century Irish history at once perceives that Ireland passed through many famines. The emigration statistics tell the tale of some of the results of the change in English commercial policy.

This country flourished before 1846, but its state was entirely artificial. No real dependence could, therefore, be placed in what had happened. With the abolition of the Corn Laws the fictitious industrial life of the country was at once evident. When free trade began, for a time this land did not prosper, but at last some measure of success has been vouchsafed. To-day an Irishman feels at least that his hardly-won industrial triumphs are all his own, that they are largely independent of State control and State support.

* Abstract of a paper read before the Economic Section of the British Association at Dublin, 1908, by Robert H. Murray, M.A.

HOME INDUSTRIES.

The Cotton Trade Dispute.—There is no sign of coming peace between the disputants. The outlook indeed grows more disturbing as the days pass without apparently any desire on either side to immediately end the lock-out. It is estimated that 36,000,000 spindles are now idle, these employing in round numbers 100,000 persons. The lessened production is said to be popular with spinning employers who think the lock-out should at least last a month in order to improve the margin between the raw material and yarn. Weaving machinery which depends on bought yarn is gradually closing down in consequence of the scarcity of twist and weft. Within the next few days it is expected that over 100,000 looms will be idle, these increasing the number of unemployed to from 200,000 to 250,000. The North and North-East Lancashire Association of Employers who have manufacturing members with spindles, have decided to take no part in the fight. The feeling grows that abitration should be proposed from influential quarters, but Lancashire is notoriously unwilling to allow outsiders, however distinguished, to interfere in its labour disputes.

Foreign Firms and the Patents Act.—The Mayor of Wigan is about to call a conference of local authorities to consider the best means of advertising the locality as a centre for the establishment of industries by foreign firms affected by the Patents Act. The contention is that Wigan can offer exceptional facilities to firms that are obliged by the Patents Act to manufacture in England or forfeit their patent rights. It is surrounded by coalfields, and has several steel and iron works, whilst its canals and railway services bring it into association with all parts of the country. According to the Mayor, there are several valuable sites for works which could be obtained at a peppercorn rent. Certain kinds of labour too are said to be cheaper at Wigan than elsewhere in Lancashire.

Trams without Rails.—A sub-committee of the Manchester Tramways Committee has been considering, and has just reported upon, the system of trackless trams, or trolley-fed electric omnibuses. The system is a compound of the omnibus and tramway systems. An omnibus equipped with one or more electric motors receives current through overhead trolley wires and a swivelling trolley arm similar to that used on tramways. But there are no rails, and the driver of the 'bus can choose his own path on the street. Mechanically and electrically the system presents no difficulties. The essential difference between the two systems is the absence of rails in the trackless system, which means the saving of capital outlay, but a railless car puts a much severer strain on the overhead construction than a tram car because of the jolting of the 'bus, and the side pulls transmitted through the trolley arm when the car passes from one side of the road to the other.

And the omnibus requires to be more strongly built than the tram car running on well-laid tracks. The railless system may be superior for infrequent services, but in great towns the tramway is likely to hold its own.

The American Cotton Crop.—Two separate reports from the United States Government warrant the expectation of a good cotton crop notwithstanding the August drought. In one of these reports it is stated that up to September 25th the number of bales ginned was 2,582,000, which compares with 1,532,607 in 1907, and with 2,057,283 in 1906, one of the biggest crops on record. As to the "condition" of the crop it is given as 69·7 per cent. on September 25th, as against 67·7 per cent. last year. But with plenty of cotton Lancashire may still starve if the industrial quarrel continues. At present buyers seem hardly to believe in the strike.

London Electricity.—Last week there was an important conference of representatives of local authorities in London and district held at Shoreditch. Representatives were present from many borough councils owning electricity undertakings, together with delegates from outside bodies whose areas are scheduled in the principal Bill to be considered by Parliament in its autumn sitting. The conference passed several resolutions—one, whilst protesting against the principles contained in the London and District Electricity Bill, expressed the opinion that a clause should be inserted so as to provide that in the event of purchase taking place in 1931 or 1936 the amount to be paid for goodwill shall not exceed twenty years compensation based upon the net annual profits of the company. In regard to the London Electricity Supply Companies' Bill it was stipulated that a sterilisation clause similar to that imposed upon the old water companies, the effect of which would be to prevent compensation being paid in respect of capital expenditure incurred as a result of the new powers being obtained should be incorporated in the Bill. The Conference also appointed a deputation to wait on the President of the Board of Trade for the purpose of asking that the borough councils should be given linking-up powers on the same lines as those proposed to be taken by the present companies.

Consequential Losses from Fire.—A leading insurance company has just issued a new policy covering consequential losses due to fire. It provides compensation for the loss of profit and income following a fire, protecting the assured against increase of working costs and the payment of standing charges, including interest on debentures, mortgages, loans, bank overdrafts, or other borrowed capital, dividends or preference shares, rents, temporary rents, rates and taxes, salaries to permanent staff, and wages to skilled *employés*, directors' and auditors' fees, insurance premiums, travelling expenses, and advertising due to partial or total interruption of business by fire." The premiums charged vary according to the measure of the risk undertaken, but approximate to the rate per cent. charged for ordinary fire insurance.

Foreign Substances in Cotton.—Recently a Liverpool firm of cotton brokers directed the attention of the British Chamber of Commerce in Alexandria to the discovery of a box of lucifer matches embodied in an Egyptian bale of cotton. "It is bad enough," they write, "to have complaints about rubbish, such as pieces of iron, steel rivets, canvas, and other *débris* being found in Egyptian cotton, but when it comes to live matches it is high time a strong warning was issued to ginners for the exercise of better supervision." Upon this statement the British Chamber of Commerce in Alexandria has made representation to the Egyptian cotton-pressing establishments, and also to over twenty ginning firms, regarding the danger of foreign substances being mixed in the bales before shipment.

Lubrication in Factories.—Often there is much difficulty in oiling small machines or tools, so as to keep them lubricated. For example, one of the difficulties encountered with piping systems is the clogging effect of chips and waste, and a correspondent writes that the plan adopted by an American tool company is to have an opening in the pipes which carry the used oil from the machines to the filters. The ordinary gas pipe employed has been cut away at the top for nearly the whole length, making a continuous slot, except at the ends, where enough stock is left for the necessary couplings and elbows. Thus there is virtually an open gutter for the oil from the machine, and any detritus in these canals can be observed and removed. The piping runs under the benches which carry several hundred machines for milling the plate in drills, and the tank is situated on the ceiling at the end of the shop. To test the oils supplied, five gallons are taken from each shipment and tested separately by a machine which has its own pipe line, pump, and filter.

Open Hearth v. Bessemer Steel.—In a paper read at the Iron and Steel Institute, which met at Middlesbrough last week, under the presidency of Sir Hugh Bell, Mr. Hawdon, dealing with the steel industries of the Cleveland district for the last quarter of a century, referred to the large increase in the tonnage of iron and steel produced in the district, most of the latter being made by the open-hearth process. The figures show that there is no increase in the tonnage of Bessemer steel for the last five years, and it is stated that 71·5 per cent. of the steel now made in Great Britain is of open-hearth make. Since the Institute met at Middlesbrough twenty-five years ago the iron industry has given place to Bessemer steel, and later the Bessemer product was superseded by the higher quality material produced by the open-hearth process. The Mayor of Middles-

brough, in welcoming the members of the Institute, gave some striking figures showing the growth of the export of iron and steel from the Tees, which has increased from 1,126,000 tons in 1880 to 2,330,000 tons in 1907. The total manufacture of iron and steel for home and export in the north-east district for the year 1907 was approximately 5,134,000 tons. Middlesbrough is now the centre of the largest iron and steel making district in the world.

OBITUARY.

General Francis Hornblow Rundall, C.S.I.—General Rundall died at Moffat on the 30th September. He was the youngest son of Colonel Charles Rundall, Madras Army, born at Madras December 22, 1823. After being educated at Kensington and Addiscombe (H.E.I.C. College), he was commissioned in 1841 to the East India Company's Engineer Corps, and he spent 30 years in India, where he held several appointments in the Public Works Department, and for seven years served in the Godavery district as assistant to Sir Arthur Cotton. He was Chief Government Engineer in the Bengal Irrigation Department, and subsequently from 1871 to 1874 Inspector-General of Irrigation to the Government of India.

General Rundall was elected a member of the Society of Arts in 1883, and in the same year he read a paper at one of the Ordinary Meetings on "The Suez Canal, its Enigneering, Commercial, and Political Aspects." In the following year he read one on "A System of National Water Regulation necessary in regard to Supply, Floods, Drainage, and Transit." At the Society's Canal Conference in 1888 he read a paper on "Inland Transport in the Nineteenth Century by Land and Water."

Besides reading papers, General Rundall was a frequent attendant at the meetings of the Society when subjects connected with irrigation were discussed, and joined in the discussion.

Sir George Livesey, M.Inst.C.E.—Sir George Livesey, Chairman of the South Metropolitan Gas Company, died at his house, at Reigate, on the morning of the 4th inst. He was born at Islington 8th April, 1834, the eldest son of Mr. Thomas Livesey, Secretary of the South Metropolitan Gas Company, and when only 14 years of age he himself entered the service of the company, of which he became Chairman in 1885. His whole life was, therefore, devoted to the business of gas making. In *The Times* obituary there is a full account of the system of co-partnership among the *employés* of his Company, which he introduced, and which was so great a success. He was a member of the Labour Commission 1891-94, and served on the War Office Committee on the Employment of ex-Soldiers 1908. Sir George was elected a member of the Society of Arts in 1873, and he was a member of the Council in 1902.

Bennett H. Brough, F.I.C., F.C.S.—Mr. Brough, Secretary of the Iron and Steel Institute, died at Newcastle-on-Tyne, on the night of Saturday, the 3rd instant, after an operation performed on Friday. He was seized with illness at the close of the sittings of the Institute, at Middlesbrough. Mr. Brough was an Associate of the Royal School of Mines, and formerly Instructor in Mine Surveying in that Department. He published in 1888 a Treatise on Mine Surveying, which has run through twelve editions.

He was elected a Member of the Society of Arts in 1896, and delivered three courses of Cantor Lectures: 1. Mine Surveying (1892). 2. Metalliferous Deposits (1900). 3. Mining of Non-Metallic Minerals (1903). Also a course of Juvenile Lectures on Perils and Adventures Underground (1906). He read several papers on mining subjects from 1886, and received the Society's Silver Medal for his paper on Mining at Great Depths (1896). He was 48 years of age.

GENERAL NOTES.

Swiney Lectures on Geology.—A course of twelve lectures on the "Geological History of the American Fauna" will be delivered by R. F. Scharff, B.Sc., Ph.D., F.L.S., in the Lecture Theatre of the Victoria and Albert Museum, South Kensington, on Mondays, Wednesdays, and Fridays, at five p.m., November 2, 4, 6, 9, 11, 13, 16, 18, 20, 23, 25, 27. Admission to the course is free.

Trade Routes in Mosul.—The usual routes to Mosul are as follows:—(1) Sea to Basra, thence river steamer to Baghdad, and thence mule or camel transport to Mosul; (2) Sea to Beirut, thence rail to Aleppo, and thence mule, camel, or waggon transport to Mosul; (3) Sea to Samsoun, thence mule or waggon transport to Diarbekir, and thence by raft down the Tigris to Mosul. The first route (Baghdad) has the advantage of a service of British steamers as far as Baghdad. The second (Beirut) is sometimes quicker but is very uncertain at present, and arrangements have to be made for clearing and forwarding goods at Beirut, and again for forwarding on from Aleppo. The Samsoun route has the advantage of a carriage route as far as Diarbekir, and is sometimes used for the transport of heavy articles; but it is apt to be closed for three months in winter. Reporting on the various routes, Mr. Vice-Consul Young (No. 4116, Annual Series), says that packages for mule transport should not weigh more than 150 lbs., or at least 170 lbs. each: for camel transport 230 lbs. Two such packages form a load. The utmost attention should be given to packing, in view of the carelessness with which the animals are frequently unloaded.

Journal of the Royal Society of Arts

No. 2,917. VOL. LVI.

FRIDAY, OCTOBER 16, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

ASSISTANT-SECRETARY.

Mr. H. B. Wheatley, who has been the Assistant-Secretary of the Society since 1879, has expressed a wish to retire, and the Council have accepted his resignation with very great regret.

They have appointed as his successor Mr. G. K. Menzies, who has been for some time Secretary to the Academic Registrar of the University of London.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Wednesday afternoon, 14th inst. Present: Sir William Lee-Warner, K.C.S.I., in the chair; Sir Steuart Colvin Bayley, K.C.S.I., Sir Athelstane Baines, C.S.I., Thomas Jewell Bennett, C.I.E., Sir M. M. Bhownaggree, K.C.I.E., J. F. Finlay, C.S.I., Colonel Sir Thomas Hungerford Holdich, R.E., K.C.M.G., Henry Luttman-Johnson, Alexander Rogers, Colonel Sir Richard Temple, Bart., C.I.E., Sir James Thomson, K.C.S.I., Thomas H. Thornton, C.S.I., D.C.L., Sir Raymond West, K.C.I.E., LL.D., Lieut.-Colonel Sir Curzon Wyllie, K.C.I.E., with S. Digby, C.I.E. (Secretary of the Section).

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1s. 6d. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE THEORY AND PRACTICE OF CLOCKMAKING.*

By Sir Henry Hardinge Cunynghame, K.C.B.

PART III.—(*continued*).

Having thus dealt with the mode of compensating the effect of temperature on the pendulum rod, we must next turn to the bob. The effect of a rise of temperature is to expand the bob, and thus slightly to increase its moment of inertia, the mass remaining the same. To counteract this it is therefore necessary slightly to raise the bob. Let us suppose the new moment of inertia after expansion about the centre of gravity becomes $I\ (1 + x)^2$ where x is the linear coefficient of expansion of the bob.

Then h changes from $99{\cdot}412 - \dfrac{k_2}{99{\cdot}412}\ \bar{c}$

to $99{\cdot}412 - \dfrac{k^2\ (1 + x^2)}{99{\cdot}412}$ for each rise of 1° C.

and $h' = \dfrac{2x}{99{\cdot}412} \cdot k^2$. (nearly)

h' being the amount of change in the length of the rod necessary to compensate the changed moment of inertia of the bob.

This is the amount that has to be compensated. Now, suppose we make the bob compensate its own change of moment of inertia. This can be done by suspending it at a point P at a distance h' below the centre of gravity G h' (see Fig. 49, p. 992). The effect of this will

* The Course consisted of Six Lectures, delivered Jan. 20, 27; Feb. 3, 10, 17, 24. In re-arranging the material for publication, the Lecturer has preferred to divide it into Four Parts.

be, when the moment of inertia of the pendulum is increased by the increase through heat of the moment of inertia of the bob, to raise the centre of gravity and thus shorten the effective length of the pendulum. If a the coefficient of expansion of the bob through heat is arranged so as to compensate the change in the moment of inertia we shall have

$$h'a = \frac{2\,a\,K^2}{99\cdot412.}$$

Whence $h' = \cdot02\ K^2$ nearly.

This then is the distance of the point of suspension of the bob below its centre of gravity in order that it shall be auto-compensating, where K is the radius of gyration of the bob on a horizontal axis through its centre of gravity and at right angles to the plane of its motion. In the case of a cylindrical bob 10 centimetres high and 10 cm. diameter, $K = 14\cdot5$, and therefore $h' = \cdot29$ c. In the case of a lenticular bob of 20 cm. diameter, the value of $K^2 = \frac{r^2}{2} = 50$. And $h' = 1$ c. This value of h' is independent of the metal of which the bob is made or of its coefficient of expansion, and this depends only on the size and shape of the bob.

We have now to deal with corrections due to the change of density in the air in which the pendulum is placed.

Of course, when a pendulum is in motion, a considerable resistance to its path is offered by the air. This resistance acts so as gradually to shorten its path, each swing being in amplitude only a percentage of the last.

But it can be shown by a mathematical computation, that though the resistance of the air affects the amplitude of the swing, it does not affect the time of swing, at all events to any extent that is appreciable, so that, as far as resistance of the air is concerned, it has no effect on the time of swing of the pendulum. From this, it might be concluded that no correction need be made for any changes in the condition of the air, so that a pendulum would keep the same time, whether in the air or in a vacuum.

This conclusion would, however, be incorrect. For though the alteration of the resistance of the air has no effect upon the time of swing, the alteration of the buoyancy of the air most materially affects it. And this effect can be calculated.

The principle discovered by Archimedes, and called after him, establishes the fact that when a body is weighed in a medium, such as water or air, its weight is less than its weight in vacuo, by the weight of the medium displaced; that is to say, by the weight of a volume of air, equal to the volume of the pendulum bob, this air being of the density of the air surrounding the bob. It further follows that the formula $T = \pi\sqrt{\frac{L}{g}}$ which is true for a vacuum, needs correction when the pendulum is swinging in air.

This correction is made by modifying the value of g. For of course, if the weight of the bob is lightened by the buoyancy of the air, its mass remaining the same, the new value of g will be found by diminishing it in the proportion that the weight of the air displaced by the bob bears to the bob itself.

This is, however, not the only correction. It has been found by a series of experiments, suggested by Newton and Bouat, and carried on by Bessel, Sabine, Baily, and Bloxham, culminating in a most important paper by Sir George Stokes, that a body moving in air carries with it a quantity of the air in which it moves.

The exact quantity of the air so carried depends on the size and shape of the bob and can only be fixed by the most elaborate experiment. Hence, then, while the buoyancy of the air lessens the value of g, the accelerating force, in the proportion which the weight of the air displaced by the bob bears to the bob; the mass of the bob is also increased in the very same proportion, which depends on the size and shape of the body of the pendulum and of its rod, and which, in the case of some of those in use, is as much as nearly 40 cubic inches. Of course this air is not all moved at the same rate as the pendulum, but it seems that we may estimate that the air so carried increases the mass of the pendulum by an amount about equal to the mass of a volume of air equal in volume to the bob, in the case of a cylinder moved at right angles to its axis, or, in the case of a sphere, an amount equal to half its volume.

Let m be the ratio of the volume of air thus moved to the volume of the bob, and μ the ratio of the weight of air to the weight of an equal volume of the metal of which the bob is composed; then if the time of vibration T becomes $T\ (1 + \delta)$ the value of $T\ (1 + \delta)$ becomes $\pi\sqrt{\frac{M\,(1 + m\,\mu)\,l}{M\,G\,(1 - \mu}}$ where δ is the proportional increase of the time.

Thus $T^2 = \pi^2 \frac{l}{g} (1)$

And $T^2 + 2\,T\,\delta + \delta^2 = \pi^2 \frac{(1 + m\,\mu)\,l}{(1 - \mu)\,g}$. (2)

Neglecting δ^2 and subtracting we have

$$2\,T\,\delta = \pi^2 \frac{l}{g} \left(\frac{1 + (m)\,\mu}{1 - \mu} - 1 \right).$$

$$\text{or } 2\delta = T\,\frac{1 + m\,\mu - 1 + \mu}{1 - \mu}$$

whence if μ is small

$$\frac{\delta}{T} = \tfrac{1}{2}(m + 1)\,\mu$$

If the bob is a cylinder of about the size of a usual bob for a seconds pendulum, then experiment shews that we may take $m = 1$.

A cubic centimetre of air at 16° C. weighs ·0012056 grammes. A cubic centimetre of lead weighs 11·4254 grammes,

whence $\mu = \frac{\cdot 0012056}{11\cdot 4254} = \cdot 00010519$.

Wherefore δ the amount of seconds retardation of the pendulum $= T \times \cdot 00010519$ seconds per second, which is equal to 9·1168 seconds per day; requiring to compensate it, a shortening of the pendulum of ·0207 centimetres, which is the amount by which a seconds pendulum rod moving in vacuo, would be longer than the same pendulum moving in air. This figure is not very different from that experimentally obtained by Sabine, who experimented upon this question in 1820 with an apparatus provided by the Board of Longitude.

We have thus seen that the buoyancy of the air introduces the necessity of a slight shortening of the pendulum from the theoretical length in a vacuum. If the density of the air remained always the same, of course this compensation could be accomplished once and for all mechanically. But inasmuch as the density of the air is constantly changing with every change of temperature, or of barometric pressure, it is necessary to examine the effect of these variations.

The density of air depends on the number of molecules in a unit volume, and this depend on its pressure, and on its temperature, and on the quantity of water vapour that it contains. For the purposes of our calculation, we may say that the density of air at a temperature of 15° C. (= 59° F.), and at a pressure of 760 mm., and with a dew point of 10° C., is, including the watery vapour it contains, ·001204—water being unity.

By the law of Gay Lussac, any increase in pressure produces an arithmetically proportional increase of density, and a rise in temperature produces an arithmetically proportional diminution of density within usual limits, and not taking special account of abnormal quantity of water vapour.

The ordinary height of a barometer is about 30 inches, or say 760 millimetres. For every millimetre diminution of the barometric mercurial column the pressure therefore is diminished by $\frac{1}{760}$th part (= ·00132). It is also a law, true for most gases within the ordinary limits of pressure and temperature, that for each 1° C. increase of temperature, the pressure remaining constant, the volume increases by $\frac{1}{273}$rd. part (= ·00366), and hence the density diminishes in a like ratio. At a pressure of 760 millimetres at 15° C. of temperature, the density of air is ·001204 (water being unity). We have, therefore, now all the data for computing the effect of changes of air buoyancy on a pendulum.

There is, however, one consideration that is of great importance, and has been previously explained. It is that, as a pendulum moves, it carries air with it. Even some feet off, the effect of a pendulum in moving the air can be seen upon little filaments of down. Hence then, the mass of a pendulum-bob is not merely the mass of the metal of which it is made, but is also the mass of the air which it sets in motion. And, of course, as the pressure and temperature vary, even though the arc and speed remain unchanged, the mass of this moving volume of air will vary, as has been said. As was previously said, from a number of experiments made by Hessel, Sabine, Baily, and others, it may be roughly estimated (and, unfortunately, nothing but an estimate is available) that for an ordinary 15 lb. cylindrical pendulum of lead, there is set in motion, and on the average carried with the pendulum, a volume of air equal to the volume of the bob. For larger pendulums less than this would be allowed, for smaller pendulums a larger proportion. The result of this is that in each case we shall have time-corrections for the swing of a pendulum, dependent (1) on the pressure of the air, and (2) on its temperature; so that if p be the increment of density caused by pressure, and it be estimated that the a volume of air is moving equal in bulk to the volume of the pendulum, if p be increase of the pressure in millimetres (p being the ordinary average pressure), g' the effective acceleration of the pendulum,

$$= g\,\frac{\text{weight of pendulum—increase of weight of displaced air.}}{\text{mass of pendulum + increase of mass of displaced air.}}$$

Now, if p be the normal barometric pressure and p' the barometric pressure at the time of observation is above the normal, then the

weight of the bob $= g \times$ volume of bob $\times$ density of lead; and the increase of weight of displaced air $= g \times$ volume of bob $\times$ density of air $\times \frac{(p')}{p}$ and if D be the density of lead, and d the density of air, the above equation becomes—

$$g' = g \frac{V\left(D - d\frac{p'}{p}\right)}{V\left(D + d\frac{p'}{p}\right)}$$

whence then if $T = \pi \sqrt{\frac{L}{g}}$ be the normal time of oscillation of the pendulum in air the new time, owing to an expansion is

$$T' = \pi \sqrt{\frac{l}{g} \times \frac{D + \frac{p'}{p}}{D - \frac{p'}{p}}}$$

If this be expanded, and quantities involving the square of $d\frac{p'}{p}$ be omitted, which will be very small, we shall find that

$$\frac{T' - T}{T} = \frac{D}{d} \times \frac{p'}{p}$$

which shows that for a cylindrical bob of about 20 lbs. weight, when the air pressure is diminished by any small given proportion, the period of vibration is increased in the same proportion. d, the density of the air $=$ ·001204, and D the density of lead may be taken as 10, after making allowance for holes in it and for the alloy of antimony.

If we take a day as the period during which the change of time is to be examined, then

$$\frac{T' - T}{T} = \frac{1}{86400}$$

whence $\frac{1}{86400} = \frac{\cdot 001204}{10} \times \frac{p'}{760}$

whence $p' = 73{\cdot}5$, showing that for each 73·5 millimetres rise of barometer, the clock will lose 1 second a day, or in English measure a clock loses 1 second a day for each 3 inches rise of the barometer.

The effect of a rise in temperature is determined in an exactly similar way.

In this case we shall have

$$g' = g \frac{D - d\frac{t'}{t}}{D - d\frac{t'}{t}}$$

Where $\frac{t'}{t}$ is the proportional increment of density due to a fall in temperature of 1° C. This will result in the equation

$$\frac{T'}{86400} = \frac{t - t}{273} \times \frac{\cdot 001204}{10.}$$

Whence $T' = t'$ ·038104, whence $t' = T' \times$ 26·8550, so that from this cause alone a clock will gain one second a day for each 26·8550 C. rise of temperature of the surrounding air. Whence then if T′ be the daily gain in seconds $T' = t'$ ·038104—p' ·013688 where t' is the increase or decrease of temperature in degrees Centigrade over 15° C. and p' is the rise or fall of the barometer (in millimetres) over or under 760 mm.

The correction of time due to rise of temperature of the air can be effected, of course, by the same compensator that corrects the expansion of the rod.

If the compensator is of brass, then since the linear coefficient of heat expansion of brass is ·000018 per 1° C., it is obvious that for a pendulum with a lead bob, the length of the brass compensator for regulation of air temperature must be 4·35 $\bar{c}$. (about $1\frac{3}{4}$ inches).

This compensation is negative, that is to say, as the temperature rises and the time of swing is increased, the pendulum must be lengthened. It is, therefore, obvious that it may be made by a simple deduction from the positive compensation of the pendulum rod, the amount of it depending not on the coefficients of expansion of the rod or bob, or on the shape of either, but simply on the density of the metal of which the bob is made. We need then only deduct 4·35 $\bar{c}$. from the brass compensator, and what is required is done.

This explains why the old clocks were nearly always over compensated by nearly two inches of brass, and why the lengths of zinc rod and mercury columns needed in practice to be always made rather shorter than simple theory seemed to require.

The disturbance due to changes of air density due to barometric changes can, of course, be prevented by an air-tight case. Such a case must be strong, for each increase of barometric pressure of an inch produces a pressure of nearly $\frac{1}{2}$ lb. on the square inch, and hence may put two or three hundredweight on the front of the clock case. The case must, therefore, be of metal or very strong wood, and if the cover is of glass, it should be as small as possible and made of very heavy plate. It is, of course, essential that the case should be rigid. A flexible case would allow outward pressures to alter internal density, and thus be useless.

Cases have been made of glass cylinders. They are, however, expensive to make, and require to be strong to stand the external pressure put upon them by considerable barometric changes. A wooden case dove-tailed

together, and covered externally with good quality india-rubber cloth, fastened on with india-rubber solution, and with a small glass in front, would probably make a cheap and serviceable case; or else the outer coating may be made of zinc or tinned plates, or of thin sheet copper. The pressure in such cases is usually rather over the normal atmospheric pressure. A small tap is employed, to which a bicycle-pump may be fitted, and an aneroid barometer is fixed in the interior of the case. By this means the pressure may be re-adjusted from time to time. The retardation on a pendulum produced by barometric pressure is, as we have seen, about one-third of a second a day for each inch of rise of the barometer when no air-tight case is employed. Barometric changes may also be compensated either by a record of a curve of the clock's time-keeping connected by the curve of a recording barometer, or else by means of barometric compensators attached to the pendulum. One of these consists of a set of aneroid vacuum chambers, fixed near the top of the pendulum, and so contrived that as they move a weight is raised or lowered. Another plan is to have a mercurial barometer attached to this pendulum with a reservoir at the bob, so that the barometer's rise adds mercury to the upper end of the tube, and thus quickens the clock's action.

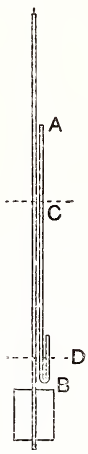
At Greenwich a contrivance was tried many years ago by which, as the barometer fell and the mercury rose in the lower cistern of a barometer, a permanent magnet was caused to approach the pendulum and to retard it. But the plan has been long abandoned.

Baily endeavoured to shew that when the barometer rose, and the air became more dense, the pendulum was retarded and swung in a smaller circular arc. This, he suggested, caused the time of swing to become less, and so compensated the tendency of the increased air pressure to diminish the value of *g* and thus increase the time of swing. The plan, however, was fanciful; and though Lord Grimthorpe speaks of it with approval, it has never been applied in practice. For it requires rather considerable arcs of swing, which are accompanied by many disadvantages.

I have contrived a small mercurial column as a corrector not only for ordinary barometric changes, but for changes in air density due either to temperature or barometric pressure, and thus to compensate for both of the above changes by one and the same action.

It consists of a tube of glass of small bore closed at the upper end A, and turned up at the lower end B, just like a barometer tube, only shorter. It is filled with mercury, but unlike a barometer tube, a small quantity of

FIG. 50.



air is admitted to the upper portion, so as to form an air thermometer. The tube is fixed so that the level of the mercury in the upper arm is just on C, the centre of the pendulum rod. If the barometric pressure alters, the column changes, and thus transfers weight from the centre of the rod to a point near the bob. A like effect is caused by a change of temperature.

The mode of calculating the dimensions of this tube is as follows. Let A C D be the tube. A C $= b$ (the part filled with air), and C D $= a$ (the part filled with mercury), the end at D being turned up.

Suppose that such a diminution of air density takes place, that the clock would be accelerated by 1 sec. a day, this would, as we have seen, correspond with a fairly heavy pendulum to a diminution of barometric pressure of 3 inches, *i.e.*, $\frac{1}{10}$th of an atmosphere, or to a rise of temperature of 26·85 C. In this case the mercury will fall a distance γ below C and rise a distance γ above D. The weight of mercury thus removed from C and added at D

$$= m = \frac{\pi d^2 \gamma \delta}{4 \times 1000} \text{ grammes} \quad (1),$$

where d is the diameter of the tube in millimetres, γ being also expressed in millimetres, and $\delta = 13·6$ the density of mercury. We have next to inquire what weight taken off at C and put on at D will retard the clock by 1 sec. a day. Let m^1 be this weight. Then

by the formula previously given, the time of oscillation will be

$$\pi\sqrt{\frac{M l^2 + m^1\left(\frac{l}{2}+a\right)^2 - m^1\frac{l^2}{a}}{g\left(Ml + m\left(\frac{l}{2}+a\right) - m^1\frac{l}{2}\right)}}$$

In this equation we can neglect $m^1 a$ whenever it simply appears as an addition to a substantially large quantity. Whence we shall obtain for the value of m^1 when the retardation is one second a day, $1 = \frac{m}{2M}\ \frac{86400\ a^2}{b^2}$, or putting in the value of l

$$m = \frac{M}{4{\cdot}32\ a^2}\quad (2).$$

The value of y is found by remembering that if the outside pressure diminishes by $\frac{1}{10}$th, then the column of mercury will fall a distance y, so that b becomes $b + y$ and a becomes $a - 2y$. In this case, therefore, $\frac{b}{y+b}$, that is to say, the ratio of the former pressure in the upper part of the tube, to the new pressure $= \frac{9}{10}$. Whence $y = \frac{b}{9}$ and as a is similarly decreased by $2y$ and the proportional pressure of the column of mercury is similarly decreased, we have also $a = 2b$. Wherefore, by equating the equations (1) and (2), and putting $y = \frac{a}{18}$, which we may do if y is not too large,

$$\frac{\pi\ d^2\ a\ \delta}{4000 \times 18} = \frac{M}{4{\cdot}32\ a^2}$$

$$\text{whence } a = 186{\cdot}4\sqrt{\frac{M}{a^3}}$$

This formula enables us to find the dimensions of a suitable tube. For suppose M = 10 kilos. and that we decide to make $a = 300$ mm. and $b = 150$ mm. Then $d = 3{\cdot}6$ mm. or about $\frac{1}{6}$th inch.

In practice it is, of course, best to select your tube first, measure it, and calculate a to suit it. There is no difficulty in filling the tube if reasonably large. If the bore is very small, the tube must be sealed at the upper end after the mercury is inserted. A plug of cork, with a fine hole, should be put in the bend to prevent the mercury from oscillating if the pendulum is moved. The tube may be attached to the pendulum rod by means of clips.

Resuming what has been said respecting pendulums, the following are the points to be considered :—

1. The value of g at any place is found from the formula. $g = 32{\cdot}1718\ (1 - {\cdot}002662 \cos 2\phi)$ where ϕ is the latitude. Its value in London is 32·19078 feet per second per second.

2. The length of the simple pendulum in London is 99·416 centimetres = 39·13929 inches.

3. From this must be deducted $a^2 \times {\cdot}0037012$ c. for circular error, where a is the angle of semi-swing in degrees. With a semi-swing of 2°, this deduction = ·0146 c.

4. From this must also be deducted ·02 c., to compensate for the difference between time in air and time in a vacuum.

5. From the length of the simple pendulum must be further deducted an amount dependent on the value of the moment of inertia of the rod and pendulum. This would equal generally about ·15 c.

6. As a result, the value of the distance of the centre of gravity of the rod and pendulum below the point of support will be obtained, and will usually be about 99¼ centimetres for a civil time pendulum.

7. In order to compensate for changes in the moment of inertia due to expansion of the bob, the suspension of the bob must be fixed at a distance, d, below its centre of gravity, where $d = {\cdot}02\ k^2$, k being the radius of gyration of the bob round a horizontal axis passing through its centre of gravity. A usual distance for this is $d = {\cdot}3$ mm.

8. The heat-compensator must be calculated to neutralise the expansion of the rod as described above.

9. From this compensation must be subtracted an amount to compensate the changed buoyancy due to change of temperature of the air. This is usually about 1¾ inches of brass.

10. The values previously obtained may now be recalculated using the new value of h lastly got so as to make the result accurate, but this is a refinement which is not necessary in practice as it makes very little difference.

An example may make the foregoing operations clear.

Let us suppose that we desire to make a pendulum that shall weigh about 20 lbs. and shall have an invar stem. The first step is to design the bob. Type metal is desirable for this, as lead under the pressure of its own weight slowly changes its form as it contracts and expands. Something more crystalline and harder is wanted. Type metal is a good material. It is easily cast, it is sufficiently hard to turn well, it takes a good surface capable of a high finish. It oxidises to a fine colour, and can be satisfactorily laquered. On the other hand it is susceptible to scratches which may spoil its appearance. On the whole it is about the best metal that can be chosen for the bob. It consists of lead with

antimony to which some tin or iron is added. A German recipe is 11 parts of antimony, 25 of lead, and 5 lbs. of iron. Another recipe is 9 lbs. of lead, 2 of antimony, and 1 of tin. Some bismuth helps to make the metal fill the moulds well, but it is too expensive for use.

To cast the bob the mould should be of iron, warmed till it is too hot for the hand to bear. Previously to being heated the mould should be painted over with rouge and a trace of size. This has an excellent effect in producing a clean casting. The type metal should be melted, and well and thoroughly stirred while hot, then skimmed and poured, not too hot. While the pouring is being done someone should keep tapping the mould with a light rod to shake up the air bubbles, and the metal may be stirred up in the mould with a red-hot iron rod.

The casting should be made about half an inch higher than the finished bob, indeed it is a good plan, if possible, to have it two or three inches too high and saw off the excess, but this is an unnecessary refinement, because if the casting is done as above recommended it should be perfectly sound.

The hole in the middle should, if small, not be cast, but drilled out afterwards from the solid; holes cast in castings are often surrounded with rotten metal. Besides, it is a work of unnecessary difficulty to put the core in truly central, and type metal is so easy to bore as to present no difficulty. A good latitude should be given for turning down. The bob should be made at least one centimetre too big in diameter and length.

I will suppose that it has been resolved to have a cylindrical bob of a pattern that appears to me to be a good one, and which I will now describe. The bob may be of 10 centimetres diameter and 12 centimetres high. This gives a cubic content of $\pi\ (5).^2 \times 12 = 942\ \bar{\bar{c}}.$ The density of the metal must now be ascertained, which is easily done by weighing it, first in air and then in water. If its weight in air is A, and its weight in water W, then its specific gravity $= \frac{A}{A - W}.$ The density is the ratio the weight of the bob weighs to an equal volume of water. The density of type metal, deducting the hole in it, may be put for the purposes of our calculation at 10. Whence, then, 942 cubic centimetres of the metal weigh 10 times as much as the weight of 942 cubic centimetres of water, that is to say, 9,420 grammes, or about $20\frac{3}{4}$ lbs. The amount by which the point of suspension of the bob must be below the centre of gravity of the bob is $d = \cdot 02\ (k^2)$ centimetres. In the case of a cylinder of radius γ and height $2\ b$

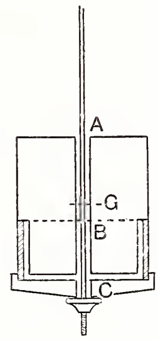
$$k^2 = \frac{\gamma}{4} + \frac{6^2}{3} = \frac{25}{4} + \frac{36}{3}$$

$$= 18 \cdot 25 \text{ square centimetres.}$$

Whence $d = \cdot 02 \times 18 \cdot 25$

$$= \cdot 3750 \text{ centimeters (about .15 in.).}$$

FIG. 51.



The form I propose for the bob is a cylinder, but with a recess on the lower part, on to which will be slipped (with an easy fit), a brass tube. Since A G = G C, and G B = .375 $\bar{c}$., A B will = 6·375 $\bar{c}$., and B C = 5·625 $\bar{c}$. The advantage of the tube is that it forms an admirable support for the bob, and at the same time is exposed to the air so as readily to take up any changes of temperature which affect the rod or the surrounding air. When the cylinder has been cast the central hole should be drilled out, commencing with a small hole from each end, and then reamed out so as to be in diameter about 2 or 3 millimetres bigger than the rod to allow of air circulation. A mandrel should then be pressed in and secured with washers and nuts. The mandrel must have dead centres, so that the bob may be put in the lathe and turned up true. This will be found an easy operation, but as the metal is very sticky, plenty of well-soaped water should be used with the tool, which should have a slight top rake (as is used in turning iron). When the recess has been made, the brass tube should be pressed on it, with a piece of thin tissue paper interposed to make it stick, and then a fine cut taken off everything, brass tube and all. So as to obtain a sightly surface, good stout brass tube should be employed, say $\frac{1}{4}$ of a centimetre thick. Of course it will be impossible to purchase the tube ready made, exactly the size wanted, so the bob must be made the nearest size possible to the tube you have got, and then the calcula-

tions of weight, at that I have given above, must be modified accordingly. The tube should project about half a centimetre below the lower end of the bob, and will thus be 6·125 centimetres long. It must be provided with a cap to rest on. This can be made of iron, say 3 millimetres thick at the outside and ·75 centimetres thick in the centre, and to lighten it, the disc or cap may have spokes like a wheel, which will also facilitate air circulation. But it must be strong enough not to bend. It should have a recess into which the brass tube is made to fit.

Now the advantage of this form of suspension is that you have the bob resting not on a point but on a circular rim, so that no sqeezing of metal will easily take place; it is easy to lift as the pendulum contracts, and as the fits are all loose it will adjust itself, so as to lie evenly on the rod. The hole through the cap should allow the rod to go through with an easy fit, so as to "wobble" naturally into position, and, to keep the rod central, a bushing of brass should be put in the top of the bob, which should also be a easy fit, and be furnished with holes to allow of circulation of air. In this way the bob will fall into position with no strain on any of the parts. The brass ring is of course to act as compensator. It would be desirable that we should know its expansion coefficient. Assuming, however, that it is ·000018 per 1°C., then, by the formula previously given, the negative air compensation necessary for our bob will be

$$\frac{\cdot 0009}{D \cdot \alpha} = \frac{\cdot 0009}{10 \times \cdot 000018} = 5 \text{ cm.}$$

and hence our total available compensation = 6·125 + 5 · centimetres of brass + ·75 cm. of iron for the iron cap. The rod will have to be arranged to meet this compensation.

The length of the rod from the axis of suspension to go about 3 cm. below the lower end of the bob will be about 108·5 centimetres, and as the suspension springs and holder will occupy say $1\frac{1}{2}$ centimetres, we may procure a piece of invar 107 cm. in length. The thickness of the rod will have to be adjusted to carry the weight without undue stretching. As a rule it may be from $\frac{1}{15}$th to $\frac{1}{25}$th the weight of the bob.

Thus for a 10 kilogramme bob the weight of the rod would be 500 grammes. This with a specific gravity of invar = 7·8, and a length of 108·5 cm. would give a diameter of ·866 cm. Hence a rod of diameter of 1 cm. would be sufficient, weighing about 600 grammes.

We will suppose that it is made of invar with a medium expansive coefficient, say ·00000130. The distance of the C of G of the bob from the axis of suspension may be estimated with sufficient accuracy at 99·5 cm. If, however, it were desired to compute it with exactitude, it would be done by means of the formula already given

$$981 \cdot 1 \left(M h + m \frac{h - b}{2} \right)$$

$$= 9 \cdot 8696 \left(M \, (h^2 + h^2) + m \frac{h - b^2}{3} \right)$$

Here M = 10·000 grammes.
m = 600 grammes.
b = 6 centimetres.
K^2 = 18·25 sq. centimetres.

From which we shall find that $h = 99 \cdot 65$ c.

The correction for circular error for an arc of $1\frac{1}{2}°$, same swing will be — ·006 cm., and the correction for the difference between the weight of the pendulum in vacuo and in air will be $\frac{0012056 \times 86400 \times \cdot 0023}{10} = \cdot 0239$ c.

h thus becomes 99·62.

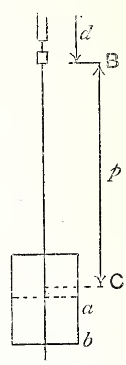
We have now to deal with the heat compensation of the rod.

The linear coefficients of expansion

$$\left.\begin{array}{l} \text{of invar is } \alpha_1 = \cdot 00000131 \\ \text{of steel is } \alpha_2 = \cdot 0000108 \\ \text{of brass is } \alpha_3 = \cdot 00001850 \end{array}\right\} \text{per } 1° \text{ C.}$$

If d is the length of the steel suspension spring and holders from the upper part of the spring, p the pendulum length down to C, the centre of gravity of the bob, μ the distance from the centre of gravity of the bob to the seating of the brass tube = ·375 cm. A is the length of the tube = 5·625 c. b = ·75 c.

FIG. 52.



Then on one side for the rod expansion we have the expressions

$$\left.\begin{array}{l} d \times \cdot 00001080 \\ + (99 \cdot 62 - d) \times \cdot 00000131 \\ + (6 \cdot 125) \times \cdot 00000131 \\ + \cdot 75 \times \cdot 00000131 \end{array}\right\} = d \times \cdot 00000949 + \cdot 00013950845$$

And on the other side for the brass expansion we have

$$\left.\begin{array}{l}(5 + 6\cdot125) \times \cdot0000185 \\ \quad + \cdot75 \times \cdot0000108.\end{array}\right\} = \cdot0002139125.$$

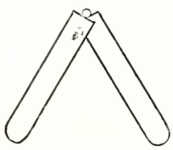
whence d the length of the steel spring and its lower chap down to its union point with the invar $= 7\cdot83$ centimetres.

This gives an ample size for the steel spring and holder for the upper end of the pendulum, and of course the length of the lower chap can be so taken as to adjust the compensation.

The suspension spring of a pendulum is usually made of steel.

Attempts have been made to employ knife-edges balanced on agate plates, but the edges are found to wear, and are not satisfactory. Attempts have also been made to employ a cylindrical pivot, rolling on arcs mounted on friction-wheels. These have also been found not to answer.

FIG. 53.

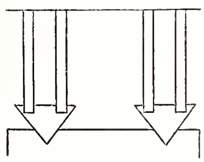


The common opinion is strongly in favour of springs.

The great fault that most springs have is a tendency to buckle. I do not mean such buckling as is produced by a kink in the spring that you can see with the naked eye, but the internal kink that you cannot see and whose presence is only revealed by an axial rotation of the pendulum—a swing performed not synchronously with the to and fro swing, but in some other period of its own. This form of buckle is most difficult to overcome. It is generally due to the spring not being truly flat, but a very little shorter down the central axis than at the edges, so that the spring tends to assume a twisted form. So great is this danger that on the Continent single suspension springs have been abandoned and double springs about two centimetres apart are employed. This seems at first to be a good practice, to which it may be added that two narrow springs on each side would be better than one, as being less likely to be buckled, if only one could be sure of being able to fix them in with the same tension. For if this is not done —if one spring is bearing all the weight while its neighbour is doing nothing—then the advantage of double springs is lost. And in the suspending of springs there is this difficulty—they are not like ropes, of which an adjacent pair will stretch till they take up the strain equally between them. Springs must be arranged so that they will not stretch, and the pins by which they are fastened must not give in the least. Moreover, the upper parts for a clock must be firmly and rigidly clamped between jaws, with the edge just taken off so as not to cut them, and no play or vibration whatever must be allowed in the upper clamps if the clock is to keep good time. On the other hand, the use of these springs enables the clockmaker to avail himself of the splendid assortment of watch mainsprings which is always at his disposal, in which the tempering and preparation of the steel leaves nothing to be desired.

It may be questioned whether it would not be a good plan to pivot the lower ends of the springs so as to ensure equal strain on them.

FIG. 54.



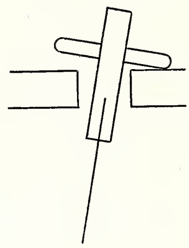
The only objection to this is that all forms of movable pins are objectionable.

There is, moreover, another danger to be guarded against. If a pair of springs are mounted rigidly in an upper block and then pinned into a lower one, if there is the slightest cross strain on them, as by pushing them together to make them fit the holes in the lower block, they will both be in an unequal state of strain relatively to their outer and inner edges, and a very prejudicial effect will be produced on the pendulum. This might be prevented if we dared to do it by twisting the springs at the upper and lower ends at right angles, so as to enable them to take up any position which the strains desire. Such a plan may be worth consideration.

But even this plan is met by another difficulty, or rather series of difficulties. If the upper clamp or chap is not at liberty to swing freely round a horizontal axis placed along the line of swing, then one of the springs is quite certain to be less stretched than the other, and to become buckled in a way that is fatal to accurate time-keeping. On the other hand, unless the upper block is fixed, it is very difficult to secure for that block that rigidity which good time-keeping requires. For if

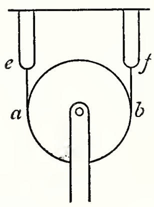
we put a pin through the upper block and rest it on faces, then, as a heavy pendulum swings, it will tend to lift up the end of the axle, and throw the whole weight on the other.

FIG. 55.



This, of course, may be largely avoided by fastening the rod on the lower block with a hook. But the disadvantage is, that with a heavy pendulum the friction on this pin is so considerable that we cannot be sure that the springs are not unequally strained.

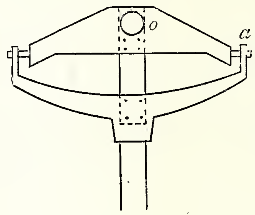
FIG. 56.



If we could use steel wire for the suspension, passing round a pully pivotted to the top of the rod, I am inclined to think that these difficulties could be largely removed, but then a round wire is not a good form for flexibility. Upon the whole I am inclined to think that the best method of suspension is a single spring of steel about ·1 mm. thick, 1 c. wide, and 2 c. long in the clear between the chaps. This should be simply pivotted on the upper end to the suspension bracket and on the lower to the rod, and allowed to fall naturally into a vertical position. But with such a spring the slightest twist will buckle it. A twist of the rod round 30° will spoil it. To prevent these accidents I recommend that arms should project from the lower chap, made of steel, with a full hole at *a*, into which pins enter, fixed to the upper chap. The metal round the hole *a* should not touch the pin *p* as the pendulum swings.

By this means it is impossible to rick the pendulum spring by rough usage of the bob, or by twisting the length-adjusting screw, while, should the spring break, the pendulum is at once caught and prevented from falling. I put one of them on an astronomical clock, and found it to answer well.

FIG. 57.



The spring should be carefully ground true and flat, hardened, and tempered to a light blue, great care being taken to equalise the heat. Springs are now made by machinery for tapes and all sorts of purposes so beautifully, and ground with such accuracy that there is no difficulty in getting them ready-made at a mere nominal price, ready hardened and tempered. The holes for the pins must be drilled with a drill made glass hard by being heated red hot and plunged into sulphuric acid. Great care must be taken not to buckle the spring in fastening it into its chaps.

ACCUMULATED TREASURE IN INDIA.

A good deal of interest has been evoked in India by the suggestion made by Sir Ernest Cable not long ago in the columns of *The Times*, that the well-known "hoarded wealth" of India ought to go a long way towards providing the additional expenditure on Indian railways recommended by the Committee on Indian Railway Finance and Administration. It may be remembered that this committee, under Sir James Mackay's chairmanship, recommended that, for some time to come, £12,500,000 per annum should be spent on railway enterprise and construction, the greater part of this being raised in London and only £5,000,000 in India. As this will entail an increased expenditure of 2½ millions per annum on railways, it becomes an important question whether the money may be counted on to be readily forthcoming, especially as the committee hint that further increased demands may be necessary in the future. And the appropriateness and desirability of India herself taking a larger share in an investment of this sort, designed to expand her resources of the country, seem unquestionable. As to the drain of gold and silver to India, there can be no question either, as the process has been going on for many centuries. As far back as the fourth century B.C. Carthage used to dispose of the silver and gold which she procured from Spain, by sending it to India, through the intervention of the Tyrians. Some four

hundred years later Pliny mentioned that a sum of money equal to three million sterling was annually exported from the Roman Empire into India. To come down to quite recent times, Mr. Clarmont Daniell, B.C.S., writing of the gold treasure of India in 1884, and quoting as basis Delmar's work on the same subject, arrives at the conclusion that between that date and the middle of the sixteenth century some £800,000,000 sterling net worth of gold and silver had been imported into India, adding that it is historically certain this has been going on for twenty-five centuries. It is unnecessary to follow in detail the annual comments of the "Review of the Trade of India," beyond saying that they supply corroboration of the operation of the general law. Sir E. Cable's suggestion is that a committee should be appointed to investigate the subject in India, and see how the native capitalists could be induced to invest their savings in Government securities, railways, irrigation works, and industrial enterprises. He also comments on what he calls the omission of the recent Committee to visit India and institute inquiries there on the points committed to them for investigation. There are, unfortunately, no reliable statistics of the amount of dormant riches in the country: that they must be enormous in the aggregate is obvious, but perhaps they are not so very great as compared with the enormous population among which they are scattered. Then the custom among the women and children of wearing ornaments on the person is very widespread, though not exactly ubiquitous, as some have asserted. Even in times of famine such ornaments are scarcely ever parted with for conversion into rupees, though at such times they are not unfrequently pawned in case of necessity. As for rupees, the largest hoards are believed to be in the possession of native chiefs and princes, who seem still to cherish the traditional idea that no property is safe unless it exist in the portable form which would enable its owner to carry it away, in case of revolution, war, or other trouble. This notion is of course a survival of the old pre-British days, when war was frequent among the tributary chiefs and States into which India was parcelled out. It is a fact that when the late Maharaja Sindhia died, about seven crores of rupees were discovered in his secret treasury. The British Government offered to pay good interest for all this money—the interest alone would have amounted to £180,000 per annum—but the Native State authorities were extremely obdurate, and only consented, after much parleying, to lend about half, at very short call. Of course, however, this was twenty-two years ago, and more enlightened views and general education will no doubt prevail in the end. Even now, as has been truly remarked, large sums of money—though small perhaps relatively to the aggregate amount of treasure retained in India—are invested in municipal loans, port trusts, tea gardens, jute and cotton factories, and other industrial enterprises. Sir E. Cable's proposal is that a committee carrying on investigations in India would be in a position to ascertain how best to familiarise the mind of native capitalists with these and other profitable means of developing the resources of the country. Care would doubtless have to be taken in the prosecution of such an inquiry so as to avoid the notion that there was the slightest intention to pry inquisitorially into the private savings of people, whether high or low. On the whole there seems little doubt that such a committee, if discreetly conducted, would result in the acquisition of much valuable information as to the economical and social condition of the people.

A SUBSTITUTE FOR CELLULOID.

According to the American Consul at Chemnitz, a German chemist has lately perfected a process which brings into competition with celluloid, a new composition possessing similar plastic and elastic properties, but free from the easy and somewhat dangerous combustibility common to celluloid articles. A few years ago the chemist obtained a cellulose acetate or acetyl-cellulose by the action of acetic acid on cotton and other forms of cellulose which possessed a high degree of compactness and toughness, but for which there was no specific technical application. Now he has succeeded in producing another form of cellulose acetate, named "cellit," which is said to be endowed with distinctly valuable properties. It is easily soluble in such solvents as alcohol or acetic ether, which do not seriously affect the health of the workmen, and what is also important, it combines with camphor exactly as does gun cotton, yielding plastic masses quite similar to ordinary celluloid. Camphor can be replaced by other organic substances, and the resultant products range from hard and tough, to soft, leather-like, even rubber-like compositions. All of these varied forms of "cellit" are perfectly transparent, totally unaffected by water, free from brittleness, and, above all, not readily combustible. Some varieties do not burn at all. Others burn in a flame, but combustion ceases when the flame is removed. The different properties of cellit are characteristic of glass, gelatine, celluloid, leather, and rubber, and it is capable of replacing each of these materials for different purposes. Probably new technical applications will soon arise, as a substance at once transparent as glass, and pliable as a woven fabric, has hitherto been wanting. It would seem to lend itself admirably for decorative effects, as it can be moulded like crystal or receive the delicate imprint of the finest designs. The sheets of cellit are prepared in all degrees of hardness for purpose of receiving impressions. The results somewhat resemble enamel, or entirely novel effects are evolved. Especially interesting are the specimens of patent leather and of linoleum coated with cellit. The designs of the linoleum are not printed on the surface of the tissue, but are part of the transparent cellit coat-

ing with greatly enhanced effect. Cellit insulation for electric wires combines the advantages over the present materials of cheapness and more attractive appearance, while occupying less space. It is claimed for cellit that a distinct field exists for it in preparing waterproof, air-tight containers for perfumery, bon-bons, &c.; in meeting many needs of the surgeon, and of the bookbinder; in the manufacture of toys, fans, and many articles of domestic use where resistance to water and pliability are the requirements. To what extent cellit can replace celluloid is not yet definitely ascertained. Certain technical difficulties have recently been overcome in blowing articles of the new substance. Such hollow objects as balls, doll's heads, and the like are now as easily prepared as from celluloid. The latest application is among the most important. It is the use of cellit films for the cinematograph. Its manifest superiority over celluloid for this purpose results from its non-combustibility. A cellit film exposed for ten minutes to the concentrated light of an arc lamp does not exhibit the slightest alteration. A celluloid film, under the same conditions, bursts into flame after a lapse of only three seconds.

INDUSTRIAL EVOLUTION IN THE CUTLERY INDUSTRY.*

The transition from handicraft to factory organisation of industry may be conveniently traced in the development of the cutlery trades, especially in England and Germany, where the trades have been mainly localised in a single town in each case, and where a definite international parallelism can be established. The introduction of steam - power, which is usually regarded as the turning point between the old and the new types of industrial organisation, had no special significance where manual skill retained its predominance. Just as there were factories before the steam-engine, so there are to-day numbers of occupations in which the domestic producer is found in possession of his special trade or process. A generation ago the cutlery trades were for the most part semi-domestic, being principally carried on by forgers, cutlers, and grinders, who rented their own work-places and worked on their own tools, thus retaining to some extent the independence and the capitalistic responsibilities of the old guild craftsman, and turning out goods in the production of which machinery played an insignificant part. The gradual introduction of mechanical methods as supplementary to, or as substitutes for, the almost bare-handed skill of the old system is gradually producing the true factory type of organisation. In fact, the factory system, though long retarded, is now making rather rapid progress, involving a steady transition from independent master workman to wage - worker, and the increasing prominence of the capitalist employer. The artisan has in the past clung tenaciously to his independence, but the semi-capitalistic functions which fall on him, prove a severe burden in times of indifferent or declining trade, and he is now generally not unwilling to resign them. The change in the status of the worker affects the power and influence of the labour unions. These made their appearance in Sheffield early in the eighteenth century, marking the practical exclusion of the journeymen from their corporate rights as members of the Cutlers' Company. During the first half of last century they were powerfully organised, and became in some cases despotic and even ruthless in enforcing their regulations on recalcitrant masters and men, and earned an unenviable reputation. Though still organised on sectional lines, they are beginning to look to federation and consolidation as necessary to maintain and increase their influence. The corresponding unions in Germany are more effectively organised, the established price-lists are enforced, and elaborate machinery for conciliation has resulted from their activity. Both in Sheffield and in Solingen machinery has taken a firm hold of the forging process, and of the work of preparing the separate portions of a knife-handle. Even the cutler who puts the pieces together, and builds up a complete article is becoming more and more dependent on mechanical aids, and finds his work increasingly subdivided. Grinding remains for the most part the stronghold of simple hand industry, for, though automatic grinding has been partially applied to grinding files, and to preparatory work on razors and knives, no device for the successful production of an edge has yet appeared.

The basis of the prevailing wage rates is still the time-honoured piecework price-lists; but though these are not yet discarded, neither are they strictly observed, but in most cases are subject to varying discounts. In the newer forms of the industry there is a steady increase of time wages, but of course this cannot apply to the considerable body of outworkers, whether grinders, file-cutters, or cutlers. Meanwhile the "little master," employing a small team of men in a single occupation, or giving out work in turn to those undertaking the various processes, and then himself trading his wares away, has not disappeared, but is numerically of less importance than formerly. In Germany the "little master" is also found, but the tendency to substitute a time wage for piecework rates is being in the main successfully counteracted by the solid opposition of the labour unions, and also by the diffusion of electrical energy among the home workers, by which means the necessity of concentrating in factories in order to obtain the benefit of modern mechanical devices is obviated. In general the tendency is for the increased cost of working appliances and the internal economies of a factory where subdivision of occupations has free scope to hasten the advent of a factory type of industrial organisation pure and simple.

* Abstract of a paper read before the Economic Section F of the British Association, Dublin, 1908, by G. I. H. Lloyd, M.A.

HOME INDUSTRIES.

The Cotton Crisis.—There is no sign of the immediate settlement of the wages dispute. The employers remain in complete agreement in insistence upon reduction, and although the operatives are now apparently willing to consent to it until January, it is doubtful whether the masters will agree to a settlement that is only to last three months. Meantime the cessation of work is beginning to be felt by outside industries. For example, already in some cases the Ulster manufacturers' stocks of cotton warp, beams and chains have been exhausted in consequence of the strike. A large number of Irish linen manufacturers have a certain proportion of their looms constantly engaged in making union or mixture fabrics, composed of cotton warp and flax weft or cotton weft and flax warp. Much cotton yarn is used in this way. Amongst the goods into which cotton yarns are thus incorporated are mercerised union dress goods, union dowlas and apron cloths, cotton and union huckaback and towels, cotton and union crashes, bleached shirting frontings, and bleached union waistings for the United States. Now that the Irish textile trade has begun to improve, the shortage in the supply of cotton yarns is a very serious matter. Most Irish manufacturers follow a hand-to-mouth system in purchasing cotton yarns, so that an interruption of deliveries soon brings looms to a standstill. Continental cotton yarns are not suitable for a large proportion of the Irish trade, which precludes much present relief from that source.

Shipbuilding on the Clyde.—The *Glasgow Herald*, in systematically compiled figures, shows how greatly the depression in shipbuilding has affected the output of the present year. The total number of launches in Scotland in September was only 31 vessels, of 21,791 tons, of which 27, of 21,201 tons, were built on the Clyde, a reduction of 26,801 tons as compared with August last, and of 16,067 tons compared with September 1907. For the nine months the Clyde output consisted of 213 vessels, of 245,102 tons, a reduction of 56 vessels, and 213,249 tons, on the corresponding nine months of last year. Not since 1897 has there been such a small output for September, or for the nine months ended September. If £20 per ton is taken for steam shipping, the figures quoted represent over $4\frac{1}{4}$ millions sterling less this year than in the corresponding nine months of last year expended on material and labour in this one industrial district. No wonder that contributory trades are depressed and that unemployment is very great. In 1897 the production was less, but that was the year of the great strike, when the engineers were unemployed of their own choice, and the trade unions contributed jointly towards the support of unorganised workers displaced by the strike. Probably the nine months total of the whole of the United Kingdom will show upwards of half a million tons short of the production of the corresponding period of last year, nor is there any improvement in the demand for floating tonnage, or in the freight markets.

Depreciation in Various Industries.—It is often a vexed question, with directors and others, as to the proper amount to be charged for depreciation. As a rule, probably the amount written off leans rather to insufficiency than excess. The "Montgomery Depreciation Tables," just published by Mr. James Moore, of 17, Donegal-place, Belfast, and compiled by Mr. H. H. Montgomery, F.A.I., will be found useful in this connection, since they give in a convenient form the results of his experience and investigation of depreciation in various industries. The tables cover twenty-five different trades and manufactures, and Mr. Montgomery subdivides the buildings, plant, and machinery in each case, setting out the approximate average safe life of each class of item, and the best rates of depreciation to use (sectional and "all over") calculated upon original cost and diminishing values. In the latter case, the rate to be allowed for book-keeping purposes is distinguished from the rate usually allowed by income-tax surveyors. The usual method of depreciation is to write off an average percentage over the whole plant, or varied percentage over sections, the rate being calculated upon original cost or diminishing values. The second and third columns of percentages in Mr. Montgomery's tables suggest that the depreciation rates allowed by income-tax surveyors are insufficient. Thus, for cotton spinning mills, the average rate of depreciation on plant and machinery, for book-keeping purposes, varies from 8 to 12 per cent., but the maximum rate allowed by surveyors is only $7\frac{1}{2}$ per cent. It should be remembered that by the Finance Act of last year "cumulative depreciation" is allowed to income-tax payers, so that if depreciation is insufficiently allowed one year an extra amount may be charged against the next year's profits.

Artesian Wells.—A correspondent of *The Times* directs attention to the growing practice of installing private water-supplies by means of artesian wells in the London area, an outcome of the high charges for water in the metropolitan district. An artesian well, giving a good supply of water, can be put down at a comparatively small cost. One well at the Bank of England which was sunk some years ago to a depth of 400 feet, gives a supply of 7,000 gallons per hour, and as a direct consequence of the high cost of water in the city the bank authorities have placed a contract with Messrs. Isler and Co. to sink another well to give such an additional supply as will render the bank independent of the future supply of water. There are other artesian water supplies in London on the premises of the Mint, Baltic Exchange, Salisbury-house, Mansion-house-chambers, and Messrs. Lipton's. The cost and working expenses of an artesian well and air-lift pumping plant for 7,000 gallons per hour in London are estimated at £700 for capital cost, and £235 per annum for working costs, including depreciation. Roughly where any occupier is paying more than £100 per annum in

water-rate it would probably pay to put down a private supply. The storage tanks are generally placed on the top of the building, and the water is either pumped direct, in one operation, or pumped into the basement of the building and then raised to the roof tanks by a separate pumping plant for distribution.

The Spinners' International Census. — Much interesting as well as useful information is given by the International Federation of Cotton Spinners' Associations in its returns just published which cover more than 111,000,000 of the 129,000,000 of cotton spinning spindles estimated to be in existence at the present time. Comparing the present figures with those of last year it will be found that the most striking features are a slightly reduced consumption of cotton per spindle, owing to the depression and concerted "short time" which have been almost universal during the greater part of the statistical year, and a greatly reduced stock of raw material at the mills, due to the slackness of trade and the expectation of a bumper crop in America. The increase in the number of spindles reported on is roughly 11 per cent., the aggregate consumption being only 6 per cent. more, whilst the stocks in spinners' hands are 18 per cent. less. A new and valuable feature of the return is to be found in the estimates of the amount of short time worked in the various countries, Great Britain unhappily being at the head of the list. A little over a fourth of all the spindles in England spin Egyptian cotton and the English share of this branch of the industry is more than two-thirds although only about half the crop comes here. The yarns spun from Egyptian cotton in Germany, France, America, and Russia, are on the average three times as coarse as ours, and of those countries in which Egyptian cotton is spun to any extent only Switzerland approaches our average of fineness.

Sir Christopher Furness's Scheme.—Moved by a desire to put an end to the acute trade dissensions which have disorganised the shipbuilding industry of the North-East coast of England, Sir Christopher Furness has invited the representatives of the trades unions concerned to confer with him and has indicated what he proposes to do. He submits to the Conference two alternative proposals, one of which eliminates the capitalist alsogether, while the other offers the worker a profit-sharing co-partnership with him. He has given until November 26 for the consideration of these proposals. He will put the shipbuilding yards of Furness, Withy, and Co., at the disposal of any union or combination of unions who will take them over and work them on the co-operative system for the exclusive benefit of the workers, or he will make the workmen limited co-partners in the shipbuilding yards. He suggests that they shall become holders of special shares to be called *employés* shares, paying for such shares by agreeing to a deduction of 5 per cent. from their wages until the amount of their shares is covered. On these shares they would receive 4 per cent. interest whether the company divides any surplus profit or not. The shares would remain at all times a marketable security. All the available surplus of profit after paying 5 per cent. interest upon capital, and making the usual provisions for depreciation, reserve, &c., would then be divided among the holders of *employés'* shares and of ordinary shares. There would be an internal council in which workmen and capitalists would be equally represented, and in which the trades unions would also be directly represented as well as the actual workmen of the company. An arbitration board would be behind the council to deal with any particularly knotty problem.

GENERAL NOTES.

TRADE WITH DAMASCUS.—Cotton textiles appear to be the principal articles of import at Damascus, and the United Kingdom is still credited with the highest percentage of these goods, especially white calicoes and madapolam. As to prints, Italy, Germany, and Austria-Hungary are in competition with the United Kingdom, and in some varieties are forging ahead. For example, flannellette comes largely from Italy, which supplies it at a lower price and on easier terms. Zephyr and voilles come mostly from Austria-Hungary. In his report just issued (No. 4080, Annual Series), Mr. Consul Devey says that the general complaint is that the British factories do not produce such a variety of designs as appeal to the fantastic taste of the East.

EMIGRATION *viâ* HAMBURG.—In his report on the trade and commerce of the consular district of Hamburg just issued (No. 4,123, Annual Series), Consul-General Sir William Ward shows that a further increase took place last year in the total number of emigrants who embarked at Hamburg, the number being 189,810, of whom 21,678 were Germans, as compared with a total of 173,483 in 1906, of whom 20,057 were Germans. As usual, the great majority went to the United States, 171,666, as against 152,134 in 1906. A further decrease is apparent in the number of persons who embarked from Hamburg last year for the United Kingdom, which may be ascribed to the effect of the Aliens Act. It may be added that a large proportion moreover of the 2,667 emigrants who left Hamburg in 1907 ostensibly for the United Kingdom were doubtless in reality bound for the trans-Atlantic countries, and intended merely to pass through the United Kingdom.

Journal of the Royal Society of Arts

No. 2,918. VOL. LVI.

FRIDAY, OCTOBER 23, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

MULREADY PRIZE.

The Council of the Society, on the recommendation of the Examiners of the Board of Education, have awarded the Mulready Prize—a Gold Medal or a Prize of Twenty Pounds—offered to the student who obtained the highest awards in certain specified subjects in the Annual National Competition of 1908, to Frederick Charles Herrick, of the Municipal School of Arts, The Newarke, Leicester, who has complied with the conditions of the competition by obtaining the mark "Excellent" at the examination in drawing from life and a commendation in the National Competition for a finished drawing of a figure from the nude, and who has also obtained a Bronze Medal for shaded drawings of hands and feet from life.

The prize was offered under the terms of the Mulready Trust, the balance of the fund subscribed to establish a memorial to Mulready having been presented in 1875 to the Society of Arts, with the view of a medal being presented occasionally to the student who should exhibit the best drawing from the nude at the annual examinations of the Science and Art Department (now the Board of Education).

PROCEEDINGS OF THE SOCIETY.

THE EXAMINATIONS OF 1908.

There has now been four years' experience of the new system of Examinations adopted in 1905, and it is satisfactory to note that the result of the alterations has been very successful, and appears to have met with the approval of all concerned. With the exception of a few minor alterations, which experience showed to be desirable, there have been practically no changes in the system adopted in 1905. Previous to that year it will be remembered that there were three grades, the upper two of which were divided into three classes, while the lower had only one class. For these were substituted the Advanced, Intermediate, and Elementary Stages, with two classes in the Advanced and Intermediate, and one in the Elementary.

It was hoped that the standard of the Advanced Stage might gradually be raised to a level considerably higher than that of the second, or Intermediate Stage. But this has not been possible or desirable. The standard of both of these Stages remain very much what they were in 1905. With regard to the Elementary, this standard has always designedly been kept low, with the view of attracting and encouraging students of lower attainments.

As regards the practical value of the three sets of certificates, it may safely be said that a certificate of the Advanced Grade (especially of the First-class) may be taken to afford an employer a reasonable assurance of a competent knowledge of the subject (so far as it can be tested by examination) on the part of a candidate for employment who presents it. A certificate of the Intermediate Grade may be taken as evidence that the person presenting it has made a study of the subject and has made some progress in that study. While an Elementary certificate in the hands of a young person shows that special study of the subject has been attempted, and its successful pursuit looked forward to in the future. It must be remembered that this grade is only intended for young persons of, or just over, school age.

It is satisfactory to note, as will be seen from Table A (p. 1014), that the numbers show a steady, though not a very great, increase, having gradually risen from 21,253 in 1905, to 22,597 this year. The numbers in the Advanced Stage have varied very little, from 4,278 up to 4,283. They were a little higher in 1906, and fell off again in 1907. In the Intermediate Stage the numbers were practically steady for the first three years, and this year show

a distinct increase, while the Elementary Stage has increased steadily from 7,397 to 8,276.

The total number of candidates at the Examinations of 1908 was 22,597 (Advanced, 4,283; Intermediate, 10,038; Elementary, 8,276). This is an increase of 874 upon the 21,723 candidates of 1907. The number of papers worked by these candidates was—Advanced, 4,795; Intermediate (including Theory of Music), 11,199; Elementary, 9,811. In addition to this there were 89 Shorthand and Typewriting candidates at the Special Army Examinations. In addition to these again £30, provided annually by the liberality of the Clothworkers' Company.

For many years past Book-keeping has attracted the greatest number of candidates, though as regards Stages II. and III., there is a slight falling off this year—5,632 as compared with 5,703. There were also 2,912 candidates in the Elementary Stage, making a total examined in this subject of 8,544. The second largest subject is, as usual, Shorthand. In this, as regards Stages II. and III., there is an increase on last year—4,432 as against 4,323—and the total number, including Elementary, is 6,806. French is now the next

TABLE A.—CANDIDATES EXAMINED IN 1905-6-7-8.

		1905.	1906.	1907.	1908.
Commercial Knowledge.	Stage III.—Advanced	4,278	4,362	4,279	4,283
	Stage II.— Intermediate	9,578	9,572	9,752	10,038
	Stage I.— Elementary	7,397	7,425	7,692	8,276
	Totals	21,253	21,359	21,723	22,597
Music (Practice)		418	467	457	432
Colloquial Modern Languages		681	644	629	615
Army Candidates		—	—	40	89
Totals in all subjects		22,352	22,470	22,849	23,733

there were 615 candidates in Colloquial Modern Languages, and 432 in the Practice of Music. The total number of candidates who were examined in all subjects by the Society of Arts during the year ending July last was, therefore, 23, 733.

The Examinations this year were held at 395 centres, in the week commencing April 10th, and lasted from the Monday until the following Friday. The results were issued at the following dates:—Advanced Stage, June 18th; Intermediate Stage, July 30th; Elementary Stage, August 27th.

The Commercial subjects included, as usual, Book-keeping, Accounting and Banking, Shorthand, Typewriting, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Handwriting, and Modern Languages. The other subject of examination was Music, divided into Rudiments of Music and Harmony.

The Society this year awarded 29 Silver and 45 Bronze medals, the former in the Advanced Stage, and the latter in the Intermediate. It also gave away money prizes to the value of £111, besides the prizes, amounting in all to largest subject, there being in all 2,732 candidates, of whom 1,053 were in the Elementary Stage and 1,679 in the two upper Stages. It is satisfactory to note the great increase in this subject of recent years, an increase which is specially marked this year, the upper Stages showing 160 candidates more than last year. Then comes Typewriting with 953 candidates in the two upper Stages and 956 in the Elementary—a total of 1,909. German shows a slight increase in the upper Stages—438 against 425—and a falling off in the lower, 302 against 341—with a total of 740 altogether. For Arithmetic there were 642 in the upper Stages, an increase on last year, while there were 1,146 in the Elementary, 1,788 altogether.

There are no other subjects as large as the above, but in the two upper Stages 353 candidates took up English, 98 Commercial History and Geography, 105 Economics, 152 Précis-writing, 181 Spanish, 43 Italian, and 34 Portuguese. The numbers in the other modern languages are insignificant, though considerable efforts have been made to encourage candidates to come forward in them, in spite of the fact that where the numbers are so few,

the examination involves, in each case, a loss to the Society. In Russian, there were altogether 8 candidates, in Hindustani 1, in Danish and Norwegian 9, in Swedish 13, and in Japanese 3. No candidate has yet come forward for Chinese, though this subject has been long in the Programme. The syllabus for the present year has been modified in the hope that it may be more attractive. In the two subjects for which examinations are only held in the Advanced Stage, 214 entered for are either practically the same, or exhibit a trifling falling off. In the Intermediate Stage there is an increase of 377. In this case Arithmetic, English, Commercial History and Geography, Shorthand, Typewriting, Economics, French, Portuguese, Swedish, and Japanese show an increase, and Book-keeping, Précis-writing, German, Spanish, and Russian a falling off, though the change in many of the subjects is so trifling that practically the numbers may be considered as identical.

TABLE B.

NUMBER OF PAPERS WORKED IN EACH SUBJECT IN 1905, 1906, 1907, AND 1908.

SUBJECTS.	1905.			1906.			1907.			1908.		
	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.
Arithmetic	154	360	514	119	512	631	107	446	553	98	544	642
English	83	235	318	52	282	334	60	262	322	60	293	353
Book-keeping	1,869	3,899	5,768	2,088	3,485	5,573	2,082	3,621	5,703	2,054	3,578	5,632
Commercial History and Geography ..	48	54	102	31	51	82	28	61	89	29	69	98
Shorthand	1,010	3,343	4,353	783	3,486	4,269	854	3,469	4,323	847	3,585	4,432
Typewriting	375	933	1,308	363	780	1,143	254	671	925	270	683	953
Economics	48	33	81	47	59	106	59	30	89	53	52	105
Précis Writing	105	104	209	84	154	238	72	132	204	50	102	152
Commercial Law ..	169	..	169	224	..	224	238	..	238	214	..	214
Accounting and Banking	208	..	208	322	..	322	302	..	302	288	..	288
French	441	657	1,098	491	872	1,363	473	1,046	1,519	535	1,144	1,679
German	180	262	442	167	268	435	152	273	425	167	271	438
Italian	21	12	33	16	30	46	21	17	38	21	22	43
Spanish	94	80	174	89	82	171	91	106	197	77	104	181
Portuguese	28	6	34	17	7	24	15	4	19	22	12	34
Russian	7	10	17	5	9	14	3	9	12	2	6	8
Danish and Norwegian	4	..	4	4	5	9	4	8	12	6	3	9
Hindustani	..	2	2	..	..	..	..	..	..	—	1	1
Swedish	..	..	..	2	10	12	..	6	6	2	11	13
Japanese	..	3	3	..	5	5	..	..	..	—	3	3
Totals ..	4,844	9,993	14,837	4,904	10,097	15,001	4,815	10,161	14,976	4,795	10,483	15,278

Commercial Law, and 288 for Accounting and Banking. The numbers of papers worked in each subject for each year, during the period under review, are set out in detail in Table B.

The number of papers worked in the Advanced Stage shows a falling off of 20—there were 4,795 this year, and 4,815 last. The numbers in the various subjects show a very trifling difference in each case. Nearly all the modern languages show a small increase, and so does Typewriting. All the other subjects

In the Elementary Stage the 8,276 candidates worked 9,811 papers, so that, as is always the case, a large proportion of the candidates in this, as in the higher stages, were content with a single subject. Book-keeping attracted the largest number, 2,912; next was Shorthand, 2,374. The next largest subject was Arithmetic, for which there were 1,146. In French, there were 1,053, a considerable increase on last or any previous year. Then comes Typewriting, for which 956 candidates

presented themselves; in Handwriting and Correspondence, 719. In German the numbers were 302, Spanish 78. In Commercial Geography 246 candidates entered. Italian attracted 25 entries. All the subjects except German and Italian show an increase. In all 6,324 certificates were granted to successful candidates, and there were 3,487 failures. It is gratifying to notice that with the considerable increase of numbers there has been a remarkable increase in the percentage of success. As will be seen from Table E the level has been rising steadily since 1905 from 57 per cent. to 64.

TABLE C.

PERCENTAGES OF SUCCESSES AND FAILURES, ADVANCED STAGE, 1908.

	First-class.	Second-class.	Failures.
Arithmetic	27·55	38·78	33·67
English	11·50	48·00	41·50
Book-keeping	9·30	56·77	33·93
Commercial History and Geography	17·24	44·83	37·93
Shorthand	9·68	44·62	45·70
Typewriting	19·63	56·67	23·70
Economics	20·76	47·17	32·07
Précis-writing	30·00	42·00	28·00
Commercial Law	8·87	48·13	43·00
Accounting and Banking	13·89	55·90	30·21
French	14·02	54·02	31·96
German	25·15	40·12	34·73
Italian	47·62	38·10	14·28
Spanish	23·38	49·35	27·27
Portuguese	100·00	00·00	00·00
Russian	100·00	00·00	00·00
Danish and Norwegian	16·67	66·67	16·66
Swedish	100·00	00·00	00·00

The general character of the results, and the manner in which the various subjects were dealt with, may be estimated from Tables C and D, which show the percentages of failures and successes for all the subjects in the two upper stages for the present year, and from Table E which gives percentages of successes and failures in all three stages for the last four examinations. The number of entries in some of the smaller subjects is insufficient for such calculations to have much value, but the percentages are given for the sake of completeness.

In the Advanced Stage the percentage of First-class shows a falling off from the standard of last year. On the other hand the Second-class shows a good increase, and the failures are less than last year. The First-class percentage in the Intermediate Stage is higher than ever before, and there is here a steady advance perceptible. In the Elementary Stage there is also a steady and continous improvement.

TABLE D.

PERCENTAGES OF SUCCESSES AND FAILURES, INTERMEDIATE STAGE, 1908.

	First-class.	Second-class.	Failures.
Arithmetic	21·32	44·30	34·38
English	6·83	55·63	37·54
Book-keeping	11·40	60·29	23·31
Commercial History and Geography	8·70	57·97	33·33
Shorthand	36·94	36·91	26·15
Typewriting	30·01	47·73	22·26
Economics	25·00	44·23	30·77
Précis-writing	26·47	40·20	33·33
French	13·00	67·00	20·00
German	17·70	47·30	35·00
Italian	41·00	45·00	13·00
Spanish	25·00	47·10	27·90
Portuguese	75·00	25·10	00·10
Russian	66·67	33·33	00·00
Swedish	54·55	36·36	9·09
Danish and Norwegian	00·00	100·co	00·00
Hindustani	00·00	100·00	00·00
Japanese	33·33	33·33	33·34

TABLE E.

PERCENTAGES OF SUCCESSES AND FAILURES IN ALL STAGES 1905, 1906, 1907, AND 1908.

Advanced (Stage III.).

	1905.	1906.	1907.	1908.
First-class	14·2	12·86	15·	12·99
Second-class	51·	49·92	47·8	51·95
Failures	34·8	37·22	37·2	35·06

Intermediate (Stage II.).

First-class	17·	20·77	19·45	22·60
Second-class	50·4	47·32	51·25	50·40
Failures	32·6	31·91	30·	27·00

Elementary (Stage I.).

Passes	57·	59·39	59·62	64·35
Failures	43·	40·61	40·38	35·55

Table F (p. 1017) shows generally the progress of the Elementary Examinations since the foundation of the stage in 1901.

Table G (p. 1018) gives in tabular form the detailed results of this year's examinations.

TABLE F.

ELEMENTARY EXAMINATIONS, STAGE I.

Year.	No. of candidates.	No. of papers worked.	No. of subjects.
1901	3902	4458	8
1902	4371	4807	8
1903	5382	6020	8
1904	6401	7203	9
1905	7397	8427	10
1906	7425	8537	10
1907	7692	8952	10
1908	8276	9811	10

A report on the Practical Examinations in Music has been published in the *Journal*.* 432 candidates were examined—a decrease of 25 as compared with last year. These examinations have been carried on continuously since they were established in 1879. The numbers have never varied within very wide limits. In the first year 117 candidates were examined. The numbers increased gradually to 276 in 1891, and to 393 in 1895. The largest number yet examined was 566 in 1900. During the last few years there has been a small but steady diminution in the numbers. The standard has not varied greatly, but is now a little higher than it was. The general level of attainment is reported by the examiners to be slightly higher than last year.

A report on the Vivâ Voce Examinations held this year has also appeared in the *Journal*.† 615 candidates entered—a falling off of 14 as compared with last year. These examinations were started in 1902, when 280 candidates were examined The numbers rose to 681 in 1904. Since then there has been a slight falling off. Examinations were held in French, German, Spanish, and Italian, there have also in previous years been a few entries for Portuguese, but none entered this year. The numbers were—French 466, German 100, Spanish 39, Italian 10. The decrease is entirely in German, where there is a deficiency of 49, the other two languages both showing a small increase. This fact, so far as it goes, seems to confirm the opinion expressed in certain quarters that the study of German is just now rather suffering from neglect in this country, a matter for extreme regret.

The Examiner in colloquial French reports on the results of his examination in very favourable terms, the candidates on the whole coming out well as regards pronunciation, intelligence, and powers of expression. In German, though the numbers had fallen off, the percentage of success was higher. In Spanish, on the other hand, the results were not so satisfactory as in last year's examinations.

The examinations in Rudiments of Music and Harmony were carried on as usual at the same time as the Commercial examinations, and the results appeared as part of the results of the Intermediate Stage. The total number of candidates shows a distinct increase on the last two years. This year there were 716, compared with 641 in 1907, and 632 in 1906. The increase was in both subjects. In Rudiments of Music 482 candidates presented themselves, whereas last year there were 413. In Harmony there were 234, as compared with 228. Of the 482 candidates in Rudiments of Music, 371 passed and 111 failed. Of the 234 candidates in Harmony, 158 passed and 76 failed. The examiner, on the whole, reports favourably on both sections of the examination.

At the request of the Army Council, the Council in 1907 arranged to hold a special annual Examination in Shorthand and Typewriting for soldiers. The first examination in Shorthand was held last year, and the second in April last at 21 centres in the United Kingdom; 5 in India, 4 in South Africa, and 1 in Bermuda. In the Advanced Stage (speed 140 and 120 words per minute), there were 11 candidates, of whom 3 obtained First-class Certificates, and 8 Second-class. In the Intermediate Stage (100 and 80 words per minute) 73 candidates presented themselves, of whom 27 obtained First-class Certificates, 29 Second-class Certificates, and 17 failed. A silver medal was awarded to the best candidate in the Advanced Stage. The number of failures, 17 out of 84 (or 20·23 per cent.), is under the average for Shorthand examinations.

A similar examination in Typewriting was held this year for the first time. There were only 5 candidates, and 4 of them passed, 1 Advanced, 2 Intermediate, and 1 Elementary. The solitary failure was in the Elementary Grade. The examinations were held at 3 centres in the United Kingdom.

The only alteration of any importance which has been made in the Programme for next year, is that the syllabus for the Advanced Stage of the different Modern Languages, has been modified, so as to render it no longer compulsory for candidates to translate technical or scientific passages. Representations have been made to the Council, from various quarters, that there were many students who

* See *Journal*, July 10th, 1908, vol. lvi., p. 807

† See *Journal*, October 9th, 1908, vol. lvi., p. 982.

TABLE G.—DETAILED RESULTS OF THE 1908 EXAMINATIONS.

SUBJECTS.	STAGE III.—ADVANCED.				STAGE II.—INTERMEDIATE AND MUSIC.							STAGE I.—ELEMENTARY.			Total of papers worked in each subject in all stages.
	Papers worked.	1st class certificates.	2nd class certificates.	Not passed.	Papers worked.	1st class certificates.	2nd class certificates.	Music Certificates.			Not passed.	Papers worked.	Passed.	Not passed.	
								Higher.	Inter-mediate.	Elemen-tary.					
Arithmetic	98	27	38	33	544	116	241	..	..	..	187	1,146	786	360	1,788
English	60	7	28	25	293	20	163	..	..	..	110	..	..	..	353
Book-keeping	2,054	191	1,166	697	3,578	408	2,157	..	..	..	1,013	2,912	1,638	1,274	8,544
Commercial History & Geography	29	5	13	11	69	6	40	..	..	..	23	..	..	..	98
Commercial Geography	..	..	..	..	..	..	..	..	..	..	..	246	161	85	246
Shorthand	847	82	378	387	3,585	1,324	1,323	..	..	..	938	2,374	1,433	941	6,806
Typewriting	270	53	153	64	683	205	326	..	..	..	152	956	727	229	1,909
Economics	53	11	25	17	52	13	23	..	..	..	16	..	..	..	105
Précis-writing	50	15	21	14	102	27	41	..	..	..	34	..	..	..	152
Commercial Law	214	19	103	92	..	..	..	..	..	..	..	..	..	..	214
Accounting and Banking	288	40	161	87	..	..	..	..	..	..	..	..	..	..	288
French	535	75	289	171	1,144	148	768	..	..	..	228	1,053	818	235	2,732
German	167	42	67	58	271	48	128	..	..	..	95	302	186	116	740
Italian	21	10	8	3	22	9	10	..	..	..	3	25	20	5	68
Spanish	77	18	38	21	104	26	49	..	..	..	29	78	57	21	259
Portuguese	22	22	..	..	12	9	3	..	..	..	..	..	..	..	34
Russian	2	2	..	..	6	4	2	..	..	..	..	..	..	..	8
Hindustani	..	..	..	..	1	..	1	..	..	..	..	..	..	..	1
Danish and Norwegian..	6	1	4	1	3	..	3	..	..	..	..	..	..	..	9
Swedish	2	2	..	..	11	6	4	..	..	..	1	..	..	..	13
Japanese	..	..	..	..	3	1	1	..	..	..	1	..	..	..	3
Handwriting and Correspondence	..	..	..	..	..	..	..	..	..	..	..	719	498	221	719
Rudiments of Music	..	..	..	..	482	..	..	194	..	177	111	..	..	..	482
Harmony	..	..	..	..	234	..	..	22	62	74	76	..	..	..	234
Totals	4,795	622	2,492	1,681	11,199	2,370	5,283	216	62	251	3,017	9,811	6,324	3,487	25,805

had a thoroughly competent knowledge of foreign languages, but to whom the technical passages formed an obstacle. It appeared to the Council that a student possessing an advanced literary knowledge of a language, would be able to turn that knowledge to account in commercial pursuits, and that he would soon be able to acquire a familiarity with the technical terms required in the special branch of industry or commerce in which he might be engaged. They therefore determined to modify the various syllabuses accordingly. It must be understood that candidates in future will be expected to show a fair amount of such literary knowledge, in the absence of which they will be better advised to enter only for the Intermediate Stage.

A trifling alteration has also been made in the Time-Table, to meet the wishes expressed by the Committees of certain Examination Centres, and, as above mentioned, the syllabus for Chinese has been re-cast.

PEAT FUEL.

In May, 1907, Mr. Erik Mystrom, M.E., was instructed by the Canadian Government to proceed to Sweden, Norway, Finland, Denmark, Germany. Holland, and Ireland for the purpose of studying and reporting upon the peat industry in these countries. Mr. Mystrom was directed to familiarise himself with the methods, processes, and machinery employed in the commercial production of fuel from peat and lignite, and such other exploitations of peat bogs as lead to commercial products. Mr. Mystrom has now reported to his Government.

Canada, like all northern countries, possesses large areas of peat bogs, estimated to cover, taking the whole dominion, 37,000 square miles, and of an average depth of from 5 to 10 feet. In the opinion of Mr. R. Chalmers, of the Geological Survey of Canada, this estimate is too low, as up to the present time no systematic investigation of the peat bogs has been undertaken, and most likely many of the peat bogs have not been recorded. These bogs have not as yet been utilised either for fuel manufacture, agriculture, or reforestization. An idea of the immense amount of fuel contained in the peat bogs can be had from the following calculation, for which Mr. Mystrom is responsible:—One cubic yard of a drained and settled bog gives at least about 250 lbs. of air-dried peat, containing about 25 per cent. moisture. A bog with an average depth of 6 feet after drainage contains, therefore, per acre 1,210 tons air-dried peat, and per square mile 774,400 tons, equal in fuel value to 430,244 tons of ordinary coal, assuming that one ton of coal is equivalent to 1·8 tons air-dried peat, which has generally been found to be the case.

The increasing population and industrial activity of Canada demand every year a larger amount of fuel, and growing scarcity of wood in the settled parts of the country, and the increasing prices of both wood and coal, are making the utilisation of the peat bogs a question of great importance. It must be remembered that the coal deposits of Canada are situated in the east and westerly provinces, leaving the interior provinces practically dependent on the coal mines of the United States, the disadvantage of which was strongly felt a few years ago when on account of the strike at these mines the available coal supply was seriously curtailed and enormous prices had to be paid. In 1906, the last year for which the returns are complete, Canada imported 4,495,000 tons of bituminous coal and 2,200,863 tons of anthracite, and the quantity imported is steadily increasing notwithstanding the increase in Canadian coal production. The consumption *per capita*, due to increasing industrial activity and growing scarcity of wood, has doubled in the last ten years. The growing value of the forests—it is roughly estimated that at present about half the population, or some three millions of people, use wood for fuel at an average of 2½ cords *per capita*—for other purposes, such as for lumber, and pulp and paper mills—adds another reason for the development of Canadian peat resources, and especially as peat for fuel purposes is fully comparable and even superior to wood.

The European countries where peat fuel is used to a considerable extent are Sweden, Norway, Denmark, Finland, Russia, Germany, Austria, Holland, and Ireland. In most of these countries large industries for the manufacture of moss litter and peat mull are established, and the consumption of these articles for bedding and packing purposes is rapidly increasing. The manufacture of peat coke, especially in Germany, receives much attention, and in Sweden several power plants, with peat gas producers, are in successful operation. The methods at present used for peat fuel manufacture depend on air drying, which has been found, notwithstanding its uncertainty, to be the cheapest and most practical method of drying. The question of economically removing the water from the peat substance is the main problem. The interest displayed by the various Governments, and assistance given in some form or other, has had a stimulating influence on the peat industries in these countries. In the countries mentioned, with the exception of Russia, Holland, and Ireland, societies receiving yearly grants from their respective Governments have been organised for the purpose of giving information and advice regarding the manufacture of peat products, and the cultivation and drainage of peat bogs. These societies, through publications, lectures, and experimentation, do a very valuable educational work, assist manufacturers and farmers with investigations and advice, and also do a great amount of good by criticising the processes and methods initiated from time to time, which in many cases prevents the useless spending of money.

As the result of his extended inquiries, Mr. Mystrom is of opinion that the manufacture of air-dried peat fuel, if properly conducted, is in Europe a sound business proposition. The conditions in Canada, at least in the southern parts of the interior provinces, are quite as favourable for the manufacture of peat fuel as in Europe. In fact, the drying conditions are more favourable on account of the longer and warmer summer. The methods and machinery to be employed for working the bogs must in each individual case be determined by a thorough investigation as to the draining facilities, nature of the bog, and local conditions.

MECHANICAL TRACTION ON TRAMWAYS AND ROADS.*

The writer mentioned that the origin of the tramways, about 200 years ago, consisted in the laying of straight and parallel pieces of timber from the colliery to the river, for the conveyance of coal. Later on, iron flat bars were fixed on the top of those sleepers, to increase the traction facilities, which gradually developed in the establishment of railways in about the year 1767. The idea of mechanical traction on common roads was, however, not abandoned, and, after a first trial in 1769, energetically revived between the years of 1803 to 1836, and periodically continued till about 1872, after which time they were obliged to stop running, on account of the imposition of oppressive taxes and other obstacles, on the part of the local authorities. This revived tramway traction; first by horse and then by mechanical power. Starting with some description of the first steam omnibns, the writer mentioned the construction of the engines and the different powers used, as steam, compressed air, gas, &c. This included the different methods of cable traction and the fireless engines. The use of steam had, however, never been allowed to develop fairly and firmly, and the local authorities seem to have done their best to hamper its service. Also the Tramway Act of 1870 proved a creation to the detriment of private enterprise. This was followed by the introduction of electric traction, with its different methods by underground or slot-conduit, by surface-contact, and by overhead wire; the latter, being the cheapest in cost, was therefore more generally used. The author mentioned that in competition with tramway traction, on account of the permanent way construction, along the ordinary roads, mechanical traction on common roads was again thought of, seeming to be preferable, requiring no rails along the roads. It made rapid developmeut, as now seen in the production of petrol, steam, and electric motor omnibuses and private carriages. The use of the motor omnibuses especially, but also of the private carriages created, however, many unforeseen and unexpected evils, as destruction of the roads, unhealthy smells from burnt petrol vapours, depreciation of property in town and country, the destructive nuisance of enormous dust waves, dangers to life of the public and many other grave difficulties. All these grave difficulties so detrimental to the public in general would have to be overcome, if mechanical traction on common roads is to become useful and beneficial to the public. The author then mentioned the necessity of consolidating the roads, and especially of finding means to prevent the raising of such tremendous dust waves, so destructive to all kinds of property in town and country. As to electric traction, the author said the destructive wave motion of the rails would have to be overcome. Details were given of the different kinds of French, American, German and English life-guards in use. Reviewing in conclusion the different methods of traction on tramways and common roads. the installations required in all its details for electric traction, those of motor omnibus garage, the very great number of breakdowns along all the roads, with permission by the local authorities to uudertake temporary repairs on the road which was never permitted during steam tramway traction, the writer maintained that steam tramway traction, properly conducted, seemed still to be capable of holding its own against electric and motor omnibus traction, under the same conditions and if the same facilities were given; cost of installation being less and cost of working being about the same, even rather less than more.

* Abstract of paper read by H. Conradi, A.S.E., before the Society of Engineers, October 5th, 1908.

ANNATTO CULTIVATION IN JAMAICA.

Annatto is employed in colouring butter and cheese, and as a dye for calico, silk, wool, skins, feathers, ivory and bone. It produces a fast colour of both yellow and red tints. The plant producing annatto dye is a native of the West Indies, and other parts of tropical America. It is a small shrub or tree, attaining a height of eight to twelve feet. It has heart-shaped leaves, and bears at the ends of the branches loose bunches of rose-coloured flowers. The fruit consists of mitre-shaped capsules covered with soft spinules, and splitting into two valves, on the inside of which are attached seeds covered with a thin coating of reddish waxy pulp. This waxy substance, when removed, is the dye known as annatto. The United States Consul at Kingston, Jamaica, says that the nature of this dye was known to the warlike Caribs, who inhabited the Lesser Antilles when America was discovered by Columbus, and they used it as a pigment to paint their faces and bodies. The plant is grown entirely from seed, which is sown before it is entirely dry, in nursery beds made in shady places. It is a hardy plant and will grow in suitable climates, on almost any soil except soils that are swampy, but it gives much larger returns when cultivated on iich lands, such as the banks of rivers and well-drained alluvial flats. The best climate for it is one where the temperature

ranges from 75° to 80° Fahrenheit, and the rainfall is abundant. When the seedlings are about four months old, at which time they should be six to eight inches high, they are transplanted, being set in holes from six to twelve feet apart, according to the character of the soil. The land is kept clear of weeds, which are hoed up and buried in trenches between the plants. Full crops can not be expected under three or four years, but seeds may be gathered in eighteen months, or even earlier. It has been calculated that the first full crop will yield about five hundredweight of seed to an acre, and this will increase for several years. When the capsules split open and show the seeds, they are gathered by women and children, the seeds extracted and dried in the sun. The seeds are valuable solely for the yellow waxy testa which envelopes them. The seeds are then put in a tub of boiling water, and the mass is stirred so as to wash off the waxy testa from the seeds. After some days it is passed through a sieve and the liquid is left for a week to ferment, and to allow the dye to settle. The clear water is then poured off, and the deposited dye is allowed to evaporate in shallow pans. When the substance is of the consistency of putty, it is moulded into rolls, wrapped in banana leaves, and becomes the annatto of commerce. The cakes are usually packed in casks for export. In Jamaica, annatto is almost entirely the production of the peasant class. The amount of annatto exported has steadily grown. In 1882 only 147,000 pounds were exported, while during the fiscal year, 1905-6, the exports reached 457,248 pounds. Owing to the drought of 1907, the crop was materially curtailed, and the exports only amounted to 290,573 pounds. Of this amount 204,730 pounds went to the United States.

RAILWAY DEVELOPMENT IN BRITISH GUIANA.

The Government of British Guiana has under consideration an offer from a London syndicate to construct and maintain a railway from the sea-board, through the centre of the colony, to the frontier of Brazil. Surveys have not yet been made, but the country has been fairly well mapped out, and no serious difficulties are apprehended. Reporting on the project, Mr. E. H. S. Flood, the Trade Commissioner of the Dominion Government in British Guiana, says that the proposed route would be about 250 miles in length, and would pass through a nearly level country, partly virgin forests and partly vast savannahs, sufficiently elevated to preclude any difficulty from swampy areas. The road, if constructed, would be within easy distance of the mountain ranges which are believed to be a continuation of the gold-bearing formation now being worked in the north. The road would be of standard gauge, and have its Brazilian terminus at such a point as to enable it ultimately to connect with the projected Brazilian line from Manoas to Bon Bista. The objective sought is to tap the Upper Amazon Valley, and to give an outlet for the freight which is now carried upwards of 1,000 miles to the mouth of the Amazon. It is upon this through traffic chiefly that the authors of the scheme hope at first for a remunerative return on their outlay. The construction of the railway is favoured by the colony and would mean a probable expenditure of some £3,000,000. There seems, however, to be a fear that the assent of the Imperial Government, which is necessary, would be withheld, Mr. Flood says, because the Colonial Office refused to sanction a similar proposition for railway construction and land concessions in British Honduras. But there the difficulty was as to the route the expert advisers of the Crown Agents differing from local opinion as to the country through which the line should run, and the expenditure neeessary to meet the railway requirements of the colony.

KERMAN AND ITS RESOURCES.

The disquiet prevalent in Persia serves to concentrate attention on those parts which lie within the British sphere, and for which, in the event of any break up of the Shah's dominions, England might be said to be in a sense responsible. From this point of view, the Consular report on the Kerman district in the south-east offers some instructive facts for consideration. The chief port is Bunder-Abbas, at the entrance to the Gulf, but the post between it and Kerman town takes thirty days; there is no telegraphic connection, and the transport of goods is so disorganised and slow that, to carry 650 lbs. of goods over the 300 miles takes at least eighty days and costs nearly £5, and yet, in spite of all difficulties, goods valued at 27½ lakhs of rupees were imported in 1907. The Consul, Major Ducat, states that if there was even a carriage road from Bunder-Abbas to Kerman, with a regular service of wagons and a telegraph line, or reasonable postal communication between the towns, not only would regular trade more than double itself, but the khans and richer Persians would send orders to India for all sorts of goods. But so far from anything being done in this direction, the postal arrangements have been getting steadily worse and worse, post after post is reported as robbed, while parcels, unless registered and insured, are never heard of again.

And yet the country has undoubted resources. The district of Jiruft, for instance (about half way between Bunder-Abbas and Bam) is a hundred miles long and several miles in width. Besides being full of minerals it is well watered, and can grow wheat, rice, cotton, tobacco, and possibly tea. For want of communication its minerals are untouched, and its agricultural productions are restricted to its own requirements. Parallel to it and about the same size is the district of Narmashir, with equal or even greater possibilities. It is practically divided be-

tween three or four landowners, who are millionaires already, and make large incomes yearly out of henna, though it has all to be sent as far as Yezd to be treated. It could export thousands of bales of cotton if there was only proper means of transporting them to the coast. The district of Rudbar adjoins, little less fertile than the other two. Within twenty miles of Kerman itself there is sufficient iron and copper to supply the whole of Persia and leave thousands of tons for export. A mining expert, who examined the deposits, found them plentiful and easily workable.

Major Ducat says that the Persians are alive to the possibilities of the district, and quite understand why at present they remain impossibilities, and there is a strong feeling growing up in favour of developing and opening it up. The Sartip of Jiruft told the Major that he could make a fortune out of indigo, if he could only introduce the necessary machinery for treating it. This is probably correct, as the synthetic indigo is prohibited in the country. Enquiries are being made about agricultural machinery and improvements, and there is a general feeling among the town people that they are clearly paying nearly twice as much as necessary for their sugar, clothes, and other necessaries, and that their present isolation offers no compensatory advantages.

The trend of these recommendations is in much the same direction as those contained in the recent exhaustive report of Mr. Glendowe-Newcomen, and the special commercial commission sent from India to Southern Persia, while some fresh evidence of local resources is brought to light. It would be satisfactory if the recent Anglo-Russian agreement which, it may be remembered, leaves England a free hand in this very region, were to encourage our Government to act in the direction of Major Ducat's suggestious.

CHINESE CATTLE.

An American firm is busily engaged at the present time in exporting cattle from the Chinese province of Shantung to Vladivostok, over 1,000 head having been forwarded in the course of a month. The representative of this firm enters the interior of the province, and purchases cattle directly from the Chinese owners, or in the regular market towns, where all kinds of produce are exposed for sale at regular periods. Exports to the Philippine Islands were formerly made from Shantung, but owing to the prevalence of anthrax and other cattle diseases, the importation into the island was prohibited. Last year, the Chinese Government prohibited the export of cattle from China to Vladivostok, but the prohibition has apparently since been removed. Recently the importation of cattle into Vladivostok was prohibited by the Russian Government officials, but this restriction has been removed. The American Consul at Tsingtau says that cattle are not bred in China to any great extent; there are no large cattle ranches, each small farmer breeding such stock as he may himself need. Cows are not used for milk by the Chinese people, but are yoked with oxen, or with any other available animal, and employed in cultivating the fields. Foreign buyers can afford to pay prices which appeal to the owners of cattle, and it is feared that if large exports continue, the country will be depleted of this kind of animal. In a few places in the province of Shantung, especially those towns where foreigners are living, the Chinese breed cows for milking purposes, and even the better class natives are taking kindly to the use of milk. It is the fear of typhoid germs in the milk that makes the sale of the tinned variety so large among the foreign population of China. Efforts have been made to introduce German cattle into Tsingtau, but without success. The local cattle are apparently more or less immune from the effects of anthrax and other diseases, as they continue living and thriving even with these diseases prevalent about them. Foreign cattle, on the other hand, die almost immediately. A few years ago the German Government brought out a dozen of the finest breeds of German cows, but within two weeks after arrival they had all died. Last year Dr. Martini, a German bacteriologist, for many years chief assistant to Dr. Koch, was sent out to China to investigate the cattle diseases, and to endeavour to eradicate them within the German territory. He has stated that, so far as he can discover, the presence of anthrax has been greatly exaggerated, although other cattle diseases exist. Dr. Martini has reported a most curious fact which has been discovered by him and his assistants as to the percentage of butter fat contained in the milk of the Chinese cows. These locally grown animals are much smaller than the European or American cows, and give a much smaller quantity of milk, but it contains 7 to 8 per cent. fat, while cow's milk in the United States seldom yields more than 2 to 3 per cent. fat, and 4 per cent. is considered extraordinary. This increased percentage of fat is said to be due to the bean cake given to the animals in China. Peanuts and beans are grown throughout the province of Shantung in large quantities, and crushed into peanut oil and bean oil, which are exported to a very considerable extent. The refuse from the mills is pressed into round cakes, measuring about eighteen inches in diameter and two to three inches thick, which are largely exported to Japan for use as a fertiliser, and also given to cattle as food. The bean cake when used is pounded in rough granite mortars and mixed with the animals' food, and all domestic animals in China seem to appreciate its peculiar flavour. The large percentage of fat contained in the milk in China makes it unsatisfactory for drinking purposes, especially for children, but it produces excellent butter in large quantities, there being very little waste material, and it is so easily made that merely shaking the milk in a stoppered bottle for a few minutes is said to be sufficient to produce butter.

ARTS AND CRAFTS.

The Ideal Home Exhibition.—An Ideal Home Exhibition, containing, amongst other (and very various) things a number of fully furnished rooms and a whole section devoted to artistic handicrafts, promised to afford an excellent opportunity of seeing how far the Arts and Crafts movement had penetrated into the ordinary homes up and down the country, and what sort of effect it was having there. One hoped to discover whether the average household lived in sublime unconsciousness of the claims of the crafts or whether it was keenly alive to them, and how far in planning a house to live in, the artistic possibilities of the ordinary and necessary furniture and utensils would be taken into account. Those of us who live in the midst of people keenly interested in art and craftsmanship take it for granted that everyone is deeply concerned in them, until we are rudely awakened by some more than usually discordant note, and then we begin to wonder whether after all we have not made an enormous mistake, and whether the great mass of people are not entirely oblivious of such-like things. On first looking round the Ideal Home Exhibition, one is driven to the conviction that neither of these conclusions is quite right. It is, after all, it would seem, very largely a question of fashion. Fashion just at the present moment is very fond of the phrase "all made by hand"—though she does not always want to pay a fair price for hand work—she has also somewhat capricious leanings towards the simple life, and both these moods are faithfully reflected in the Exhibition. We have in the gallery a crowd of small stalls where hand workers of all sorts and descriptions show their wares. There is very little doubt about their being hand-made. Whether they are quite invariably the better for that is an open question. In the body of the hall, where a number of manufacturers and shopkeepers exhibit, hand-made work is, except in very few cases, conspicuous by its absence. The two sorts of production and distribution seem to be sharply divided. The handworker in the main shows his or her own wares, and the shopkeeper sells the product of the machine. It seems rather a pity that the two do not work together more generally.

The Furniture and Decoration of the Ideal Home.—The simple furniture shown is not, on the whole, so attractive as a good deal that is being made on the continent. The shapes suggest too often affectation rather than simplicity. To use some of the chairs in a dining-room would be rather like ostentatiously inviting one's friends to sit in the kitchen. There is no attempt, either, to use simple chip-carving or gouge work to ornament this rather plain kind of furniture. Very good work, constructed on simple lines, is being turned out in England at the present moment, but it is, unfortunately, very expensive, and we seem to be behind Switzerland, Austro-Hungary, and other continental nations in the production of cheap, or comparatively cheap, chairs, tables, and the like, which are sufficiently good in design and workmanship. Some of the doors and windows, too, in the various stands at Olympia are fitted with simple glazing, which is quite out of scale with its surrounding woodwork without having the excuse of being particularly beautiful in itself. It is difficult to go round the Exhibition without feeling sorrowfully how much more anxious people are to do do than to learn. There are a few stalls in the gallery (notably those of the School of Art Wood-carving and the Birmingham Guild of Handicraft) where really good craftsmanship is being shown; there are one or two exhibits on the ground floor which prove that some of the manufacturers and dealers are trying to put good work upon the market; but the Exhibition as a whole reveals the depth of public ignorance. It is, it would appear, easier and at the same time more gratifying to the amateur to learn to embroider, to carve, to do poker work, or to make bead chains than to acquire a real appreciation of what is beautiful—and so the Ideal Home is to be adorned (?) with patches of these various kinds of work instead of being made beautiful from basement to garret by the controlling taste of the person responsible for its furnishing and decorating.

Arts and Crafts and Home Industries.—There seems to be a good deal of misconception about as to the origin and meaning of the Arts and Crafts movement. The catalogue of the Ideal Home Exhibition, which includes several special articles (some of them very good) on architecture, art, and home industries, shows in one of its papers how completely the origin and the early scope of the movement have been forgotten in many quarters. People whom one would expect to know better seem to think now-a-days that "arts and crafts" and "home industries" are practically interchangeable terms. If that were so it would hardly be to the credit either of art or of craftsmanship when we consider what "home industries" very often amount to. It is about time that the two ideas became disentangled in the mind of those interested in art and industry.

The Arts and Crafts Exhibition Society and the Home Arts and Industries Association represent, both in their origin and their aim, two quite different movements. It is true that both bodies had in view the improvement of art as applied to industry, but they approached it from widely different standpoints and by very different methods. The Home Arts and Industries Association dealt mainly, as its title shows, with the simpler industrial arts which could be carried on in country districts during the winter months, and its members were for the most part philanthropic persons who wished to improve the moral, physical, or intellectual conditions of the peasantry and labouring classes in the villages. The Arts and Crafts Exhibition Society, on the other hand, was a body consisting mainly of artists; but including a few enlightened manufacturers. Its object was mainly to

insist upon the importance of the industrial arts, to convince the outside world that the whole province of art was not covered by the "fine arts," but embraced, on the contrary, a countless number of minor arts connected with manufacture and industry not one whit less important in their own way. It seems hardly possible now, just twenty years after the first Arts and Crafts Exhibition that these things needed to be insisted upon, but they certainly did in those days: indeed, educated people were heard to exclaim when they first entered the New Gallery, "But, where are the pictures?" Side by side with this aim was the desire to obtain recognition for the designer and the skilled craftsman who, at that time at least, were too often quite unknown to the outside public because they were employed by firms who in many cases took the whole credit for their work and would not allow their names to appear. The Exhibition, it seems necessary to add, was not under royal or any other patronage and the modest list of "guarantors" in which by the way the name of the Society of Arts occurs, includes no title save that of one single knight batchelor. It is rather difficult to reconcile this simple and workmanlike beginning with the numerous provincial exhibitions of art and craftsmanship, more or less amateurish, patronised by local magnates which, under the name of "Arts and Crafts" have become so popular in recent years. The discrepancy, however, is partly accounted for by the fact that these shows have no connection with the Arts and Crafts Exhibition Society—beyond the perhaps not altogether creditable fact that their promoters have borrowed the name of "Arts and Crafts" without very often any acknowledgment of what they owe to the Society.

It may, indeed, be maintained, with some show of reason that, whatever may have been the original object of the Arts and Crafts Exhibition Society, its aim at present seems to be largely to encourage craft at the expense of manufacture and to insist that every workman should make his own designs, or at least that all designs should be made by workmen. That may be the view of some members of the Society, and even of an increasingly large number of them, but it has never been accepted by the Society as a corporate whole. It is no doubt desirable that bodies which, like the Home Arts and Industries Association and the Arts and Crafts Exhibition Society, are interested in kindred subjects, should be on friendly terms. It is also a good thing that people anxious to secure recognition for the artist and the artist-craftsman should care for the well-being of the humbler worker. It is perfectly obvious that in applied art good work can only result from co-operation between those engaged in the production of whatever is being made, and that all must have their due. Art and industry are often two sides of the same thing; but no good can come of contending that they are of necessity identical, of restricting art to what every cottage workman can do, or of asking of the ordinary craftsman what can only be achieved by a competent designer. It appears as though at the present moment both parties would gain if their relative positions were more carefully distinguished and more frankly acknowledged. Too much bad workmanship passes muster, because it is supposed to be artistic, and too much amateurish art is condoned because it is "made by hand." The ideal should be, of course, good art and good craftsmanship—which are more likely to be arrived at if they are accepted as two branches growing from one trunk than if they are regarded as being one and the same.

GENERAL NOTES.

Turkish Bedsteads.—Foreign bedsteads made their appearance in Bagdad some eighty years ago, when British merchants first came to enter into the trade of the district. At that time the beds were not introduced to be sold, but were brought by these pioneer traders to add to their own comforts, of which Bagdad could at that time offer but few. The only bed then known to the natives was, says the American Consul at Bagdad, a queer rectangular structure, which continues to be largely used. It resembles a bird-cage with the top off, and is very cheap—being built of the dry branches of the date palm. It has an opening on one side, into which a person seats himself, then, throwing the feet up, he turns until the body is properly inside. It is estimated that 20 per cent. of the population of Bagdad, which is believed to be 200,000 souls, employs this style of furniture. Other bedsteads much in vogue are coarsely built of wood; they are called "takets," and are used by the better class; they range in price from 6s. 2d. to 30s. It is interesting to note that a very large "taket," sometimes measuring as much as ten feet square, is found in the houses of some of the notable families of Bagdad. They are usually heirlooms, built of expensive wood, and in most instances elaborately carved. These old-fashioned beds are no longer manufactured. Their values range from £5 to £10. About 60 per cent. of the population of Bagdad possess no beds. These people rest on blankets spread on the floors of their houses in the winter and on the roofs in the summer. Owing to the excessive heat, sleep is frequently made impossible elsewhere than on the roof or in the open gardens. Inasmuch as the climate is very dry, there is little to fear from exposure to the night air. While a considerable number of the roofs are surrounded by lattice-work to ensure a certain amount of privacy, by far the larger number are quite exposed to the gaze of curious and inquisitive neighbours. Comparatively few foreign iron bedsteads reached the Bagdad market until recently, this being principally due to the fact that no attempts were made to introduce them. About six years ago, however, British beds began to be imported, and these imports have since rapidly increased.

Journal of the Royal Society of Arts

No. 2,919. VOL. LVI.

FRIDAY, OCTOBER 30, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

SECTIONAL COMMITTEES.

The following is the list of the Indian Section Committee, as appointed by Council:—

INDIAN SECTION COMMITTEE.

Sir William H. White, K.C.B., LL.D., D.Sc., F.R.S. (Chairman of the Council).
Sir William Lee-Warner, K.C.S.I. (Chairman of the Committee).
Sir Frank Forbes Adam, C.I.E.
Lord Ampthill, G.C.S.I., G.C.I.E.
Sir Athelstane Baines, C.S.I.
Lieut.-Colonel Sir David William Keith Barr, K.C.S.I.
Sir Steuart Colville Bayley, K.C.S.I., C.I.E.
Thomas Jewell Bennett, C.I.E.
Sir M. M. Bhownaggree, K.C.I.E.
Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D.
Sir James Bourdillon, K.C.S.I.
Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.
Sir Charles H. T. Crosthwaite, K.C.S.I.
Sir Charles A. Elliott, K.C.S.I., LL.D.
James Fairbairn Finlay, C.S.I.
Sir Frederic W. R. Fryer, K.C.S.I.
K. G. Gupta.
Lord Harris, G.C.S.I., G.C.I.E.
Colonel Sir Thomas Hungerford Holdich, R.E., K.C.M.G., K.C.I.E., C.B.
Sir Philip Perceval Hutchins, K.C.S.I.
Sir Seymour King, K.C.I.E., M.P.
Sir Frederic S. P. Lely, K.C.I.E., C.S.I.
Henry Luttman-Johnson.
Sir Charles James Lyall, K.C.S.I., C.I.E., M.A., LL.D.
Sir James Broadwood Lyall, G.C.I.E., K.C.S.I.
Sir James Lyle Mackay, G.C.M.G., K.C.I.E.
Colonel Sir Colin Campbell Scott Moncrieff, K.C.S.I., K.C.M.G.
Sir Patrick Playfair, C.I.E.
John David Rees, C.I.E., M.P., M.V.O.
Right Hon. Sir Joseph West Ridgeway, G.C.B., G.C.M.G., K.C.B., K.C.S.I.
Field-Marshal Earl Roberts, K.G., K.P., G.C.B., G.C.S.I., G.C.I.E., V.C.
Alexander Rogers.
Sir Edward Albert Sassoon, Bart., M.P.
W. S. Seton-Karr.
Sir Charles Cecil Stevens, K.C.S.I.
Colonel Sir Richard Carnac Temple, Bart., C.I.E.
Carmichael Thomas.
Sir James Thomson, K.C.S.I., M.A.
Thomas H. Thornton, C.S.I., D.C.L.
Alexander Falconer Wallace.
Sir George Watt, C.I.E., M.B., C.M., LL.D.
Sir Raymond West, K.C.I.E., M.A., LL.D.
Field-Marshal Sir George Stewart White, G.C.B., G.C.S.I., G.C.M.G., G.C.I.E., G.C.V.O., V.C.
Sir Arthur N. Wollaston, K.C.I.E.
Lieut.-Colonel Sir Curzon Wyllie, K.C.I.E., C.V.O.
Colonel Charles Edward Yate, C.S.I., C.M.G.
S. Digby, C.I.E. (Secretary).

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE THEORY AND PRACTICE OF CLOCKMAKING.*

By Sir Henry Hardinge Cunynghame, K.C.B.

PART IV.

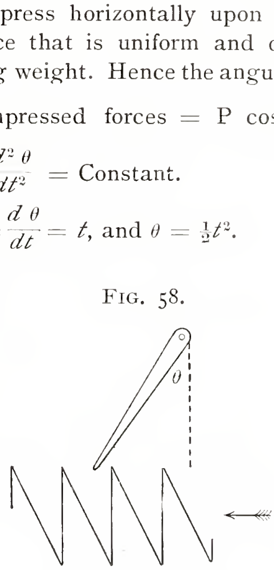
Escapements.

By an escapement is meant the arrangement by which a weight gradually runs down, and turns a wheel. The wheel has teeth which, while they slip past a projection attached to the pendulum also give it an impulse so as to keep it going. The escapement thus serves both as a counting and also as an impelling mechanism. In the crown wheel escapement, the teeth press horizontally upon the pallets with a force that is uniform and depends on the driving weight. Hence the angular moment of the impressed forces $= P \cos \theta \times \frac{a}{\cos \theta}$

Hence $\frac{d^2 \theta}{dt^2} = \text{Constant}.$

Whence $\frac{d \theta}{dt} = t$, and $\theta = \frac{1}{2}t^2$.

Fig. 58.



So that the cross staff will tend to oscillate more slowly in the middle and faster towards the extremities of an oscillation, thus making the motion rather jerky.

* The Course consisted of Six Lectures, delivered Jan. 20, 27; Feb. 3, 10, 17, 24. In re-arranging the material for publication, the Lecturer has preferred to divide it into Four Parts.

And it is obvious that no arrangement of the verge and pallets can make this escapement isochronous. In each case it will depend on the weight of the balls on the cross staff, and on the amount of the driving weight. It is therefore very unsatisfactory.

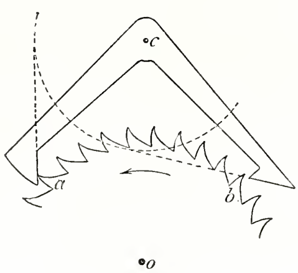
The use of the pendulum is a great improvement, and it is quite easy to turn a verge clock into a pendulum clock, merely by substituting a pendulum for the cross staff. This change was made in most existing verge clocks towards the end of the seventeenth century, so that it is rather rare now to find an old clock with a verge escapement.

The great fault of the crown wheel when used with the pendulum, is the wide swing which it is necessary to give to the pendulum in order to make it work.

As we said when dealing with pendulums, the circular error is not great when the total swing is under 3 degrees. But when the swing increases to 10 or 15 degrees, any variations in in it becomes a serious source of error.

Therefore to enable an escapement to work with but a small swing, Hooke invented the anchor escapement. This escapement is thus designed. First draw the escape wheel having

FIG. 59.

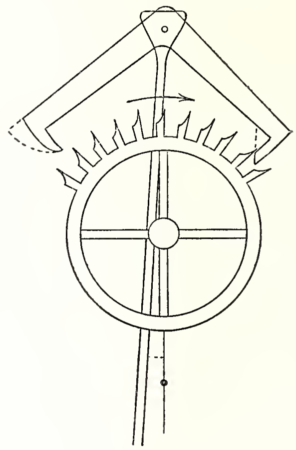


30 teeth. The teeth should be slightly curved and about as deep as they are wide. Let O be the centre of the escape wheel and A be one of the teeth, and B a tooth nine spaces off. From *a* and *b* draw tangents to the circle in which the points of the teeth lie, and let then lines meet in *c*. with centre *c* and radius $= \frac{1}{2}\, o\, c$, draw the dotted line. From *a* and *b* draw tangents to the dotted circle then the points of those tangents near A and B are the faces of the pallets. They are generally rounded off in practice as this is found to wear better. Through a point midway between *a* and the preceding tooth, draw a circle with centre *c*, to form the other part of the pallet and then complete the anchor according to taste, so that the arms should be light and yet strong enough for their work

As the escape wheel revolves, the tooth strikes the pallet face. As the pendulum is, at that moment carrying the crutch from left to right, the tooth will be carried up along the plane. This causes a recoil of the wheel, which thus applies to the pendulum a backward acceleration dependent on the force of the driving weight, and this acceleration is applied at the end of the arc, the very worst time at which it can be applied. Hence, then, such clocks will exhibit an appreciable error. For the pendulum instead of being allowed to have its swing out in comfort, is caught and pushed back before it can accomplish that swing. Hence, then, this push quickens the motion, from whence it follows that an increase in the driving weight of any clock, with an anchor escapement, will cause the clock to gain.

But yet these escapements keep very good time. They are on all the old "grandfather clocks," many of which have now gone nearly 150 years.

FIG. 60.



The improvement effected by Graham, and called the dead beat, very small though the change, is exceedingly great. In the first place, he included usually ten teeth instead of nine. The rest of the construction was exactly like that of an ordinary anchor, except only that he cut out portions of the pallet faces as shown in the drawing (Fig. 60). These nicks are made by drawing circles, with centre, C, through the point, A *a*, and the point midway between *b* and the next tooth.

The effect of this was that a tooth, instead of impinging upon an inclined plane impinged upon a dead face perpendicular to its direction of motion. This had the effect of

doing away with the recoil, for as the tooth slid to and fro along the surface, the escape wheel remained steady. When it has got down to the end of the pallet plane it is free to fly on. It does so, but the motion of the escape wheel is almost instantly stopped by the next tooth which impiges on the dead surface, first runs along it, then returns, and finally slides down the face.

Before we can criticise this escapement it is necessary to take into account some mathematical considerations which I will now endeavour to outline. Suppose that during a part of the path of a pendulum it is exposed to a retarding or to an accelerating force, other than gravity and acting in the direction of its path. What will be the effect of this on the time of oscillation ?

Of course we see at once that the arc will be either increased or diminished according as the force acts with or against the direction of motion. But what will be the effect on the time ?

Suppose, for instance, that each time the pendulum passed a certain point an impulse were given to it. It is obvious in the first place, that if the impulse were given exactly at the lowest point of the swing no effect would be produced on the time. For our examination of the motion of a pendulum shewed us, that when the bob is shot off from the lowest point with any given velocity, it will swing out and in again in a certain time quite independent of its veloclty at the lowest point. It, therefore, follows that no mere acceleration of the path at the lowest point will in any way affect its time of vibration, but it is quite otherwise with an interference at some other part of its path.

If, for instance, it bumped up against a stop, it would be arrested before its quarter second of time of swing from the lowest point had elapsed. If the bump entirely arrested its action, and reduced it to rest, it would then take a quarter of a second to descend again to the lowest point. On the whole, therefore, its time of swing would be shortened.

If instead of a bump, it were exposed to a retarding force at a distance along its path from the lowest point of its swing, then its path upwards would be shortened, and so also would its path downward. But the retardation as it proceeded upwards would aid the acceleration of gravity by helping to destroy its initial velocity. This would shorten the time. But on its return, if the disturbing forces acted the other way and now diminished the action of gravity, this would lengthen the time. So that in this case the swing up would be performed in a less time than the retutn swing down again.

Let us take some examples. Suppose that we affixed to a pendulum a small fine spiral spring on one side. This as the pendulum went up would act with the force of gravity and hence by increasing it, would shorten the time of swing upwards on its return, the spring would also act with gravity and again shorten the time, so that this plan would shorten the time of swing of the pendulum.

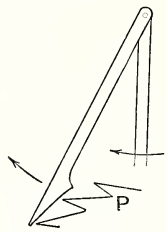
But if instead of this spring which tended to pull it back both on its outward and return path, some contrivance were made which pushed it as it went up, and thus by acting against gravity lengthened the time of swing, and which pulled it as it went down and thus by acting with gravity shortened the time of swing, it seems not improbable that the lengthening of the time going up might be compensated by the shortening of the time going down, and thus its average time of a double swing be the same ; or on the other hand, suppose that the pendulum as it passed the lowest point rubbed against a spring, then the acceleration each way would act against the force of gravity tending to lessen its acceleration force downwards, and to lessen its retarding force upwards and, therefore, the time of vibration would be increased.

These anticipations are found to be borne out in theory. The investigation was first made by Sir George Airey, who shewed that if a pendulum met with an acceleration through a small arc, x, at a distance, a, from its lowest point as it was going downwards, and also an acceleration through a small arc, x, in the same direction at a distance, a, on the other side of its lowest point as it was going upwards, the total effect upon the time would be *nil*.

This theory he used to explain the excellence of the dead-beat Graham escapement. For this escapement by the impinging of a tooth, P, upon an incline pallet, produces a horizontal thrust upon the pendulum, which thrust is of about equal extent on each side of the vertical. So that here you have almost exactly the conditions of the theoretical problem, the acceleration produced during the descent of the pallet acts with gravity and accelerates the speed of motion. During the ascent of the pallet the acceleration acts against gravity. The net result is that a pendulum actuated by a dead-beat escapement has the same average of time swing as a free pendulum, whence it

would follow that differences of impulse would not affect the rate of the clock.

FIG. 61.



The formula given by Airey is as follows:—Suppose that the pendulum receives an impulse during its passage from a point c on one side of the initial to $-c'$ on the other side, let a be the arc of semi swing, F the accelerating force due to the impulse on the escapement. Then the proportionate decrease of time of swing due to the escapement is

$$= \frac{F\,l}{2\pi g a^2}(c' + c)(c' - c) \text{ nearly.}$$

$$= \frac{\mu F}{a^2}(c' + c)(c' - c), \text{ where the}$$

pendulum beats seconds.

Here F is the force acting on the pendulum resolved along the line of motion, a is the semi arc of swing, $c' - c$ is the arc of impulse, being c on one side of the centre and c' on the other; $c' + c$ is the unlocking arc (c' being negative), and μ is a constant.

From this equation we see that the disturbance varies as the driving force, and the arc of impulse, and the unlocking arc, but is smaller in proportion as the square of the arc of swing is bigger.

Now, F $(c' - c)$ is the energy given to the pendulum, being the force acting on it multiplied by the distance through which that force acts. It will not be an unreasonable assumption to make, that for any arc the energy necessary to be given at each double vibration to maintain that arc, varies as the energy stored up in the pendulum, that is M h, where h is the height of the pendulum, at the end of its swing above the lowest point. But by geometry $h = \frac{a^2}{l}$. Whence, then, $\frac{F\,(c' - c)}{a^2}$ will be a constant, and the formula for the disturbance becomes $\mu\,(c + c')$ where μ is some constant.

This shows us that the only effect of a Graham escapement upon a free pendulum will be to accelerate it by an amount proporportional not to the driving weight, nor to the weight of the bob, nor the arc of impulse, nor the swing; but only to the arc of unlocking, which is almost negligible. This proves that a pendulum, with a Graham escapement, swings practically in the same time as a free pendulum.

This, however, is not really what we want to know, moreover the above calculation is made neglecting friction. But friction is of the utmost importance, and what we want to know is whether, taking it into account, an increase or diminution of the driving weight, in the bob, will influence the going of the clock.

Now the driving force varies with the force of the clock train, and hence is not uniform, but is different in summer and in winter. At first sight this objection appears to militate against the Graham escapement, and this would be the case were it not that by the nature of the contrivance a compensating force comes into play. For the accelerating influence of the unlocking space, and which depends in amount on the driving force, is opposed by the retarding influence due to the dragging of the teeth along the dead face of the escapement, which is also dependent for its amount on the driving force, and, by a skilful arrangement of parts, these two can be made to compensate one another. For all that is needed, as soon as the clock has been made, is to try varying weights of the pendulum with different driving weights, so as to produce different arcs of swing. By experiment a point will be reached at which any addition of a small amount to the driving weight makes the clock gain a little. If, now, the deprivation of an equal weight also makes the clock gain a little, then it is clear that an equilibrium point has been reached, at which an alteration of the driving force will have a minimum of effect. Thus, then, the friction that Sir George Airey left out of account in his calculations turns out in reality to be the true reason of the excellence of the dead-beat escapement. The adjustment can only be made by trial, but this has been done years ago by experienced clockmakers, such as Vulliamy and Dent. Hence it is best, as a rule, to adhere pretty strictly to their designs, so as to take advantage of their knowledge.

Nothing is more rash than to put any pendulum into any clock, and then expect the dead-beat escapement to perform very well. This is one of the cases in which old experience is better than new calculation, and as long as the dead-beat escapement shall continue to be used, it seems of necessity that its

design must be dictated by experience, rather than by theoretical considerations.

There are, however, a few points which deserve attention.

In the first place, the pallets should be as hard as possible, preferably of sapphire, and polished perfectly so as to give no hold for dirt. The escape wheel should have teeth of hammered brass. This works more smoothly, and wears less than steel. The whole train should be as light as it is possible to make it, so that the bump of the teeth on the pallets should be a minimum, and for the reason that the energy of a moving body varies as the square of its velocity, the size of the wheels, particularly the escape wheel, should be as small as possible, compatibly with allowing an effective space for the unlocking of the teeth. An inch radius is not an uncommon size.

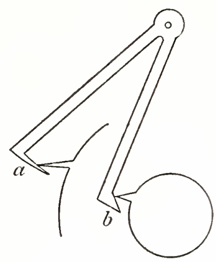
In theory, the pallets might be fixed to the pendulum, but a little reflection will show the inconvenience of such a plan. For it would need a delicate adjustment to fix the pallets correctly on the pendulum, and to get their centre of action at the proper distance from the centre of the escape wheel. Besides, a rotational twist of the pendulum might break them off. As a rule, the pendulum is hung so that its approximate centre of oscillation is in a line with the crutch. In the best clocks, the crutch is adjustable, so that the pallets work easily on each side of the escape wheels, even though the clock should be a little out of the level, a defect which is easily perceived by the inequality of the tic-tac.

A very light crutch does not add perceptibly to the work of the clock. It may be hung, if desired, to a spring, like the pendulum.

The Graham escapement carries the principle of locked escapements to its furthest point, and is so excellent that little more is to be looked for in that direction. There is, however, an improvement that can be added to it, or to any other form of escapement, namely, a duplex movement.

It will be remembered that in the Graham escapement each pallet contained an impulse face, and a dead, or locking face. It is desirable naturally that the pressure of the escape wheel on the locking face should be light. With this aim these faces are sometimes separated, and each actuated by a different set of teeth on the escape wheel, so that the pressure on the dead face at *a* is light, and that on the impulse face, *b*, is heavy. This has been made use of in watches and is called the duplex escapement. It would be of use in clocks, were it not that, as has been explained, the pressure on the dead faces instead of being useless, is positively useful. Accordingly this plan has been rarely if ever employed for anchor escapements.

Fig. 62.



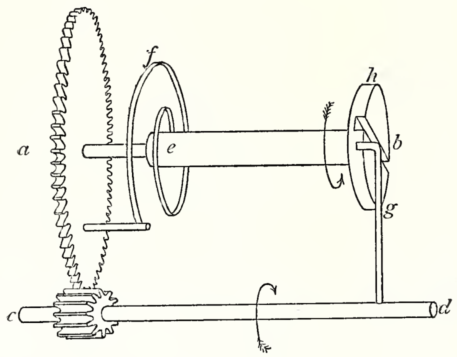
Another contrivance that may be used with almost any form of escapement is the remontoir. By a remontoir we mean an arrangement whereby the escape wheel is directly urged forward by gravity or by a spring, without the intervention of any train of wheels. The result is that the constant impulse is not subject to suffer any diminution by transmission and, therefore, heat and cold, oil, dust and other causes that contribute so much to irregularity of driving power are done away with.

Of course if the remontoir could be so arranged as to be wound up once a week the arrangement would be perfect. That it is quite impossible to put a string of such length or a spring of such magnitude on a remontoir, thence provision must be made for frequent rewinding of the escape wheel. This of course can be done by fixing a winding arm and small spring on the escape wheel and then using the clock train and weights to wind up the escape wheel from time to time. This arrangement is shown in Fig. 63 in a form that it merely diagrammatic, not fit for working.

An axis, *a b*, is capable of receiving motion from a winding arbour, *c d*, which is connected with a train of wheels and a driving weight. The axis carries a sleeve, *e b*, which is driven by *a b*; through the medium of a spiral spring, *f*, *e b* is attached to the escapement. As soon as the winding arbour, *c d*, has completed the work of winding up the spring, an arm, *g*, comes into contact with a cam, *h*, mounted on the sleeve, and which stops it. As the escapement runs on, a slot in the cam comes opposite the arm, *g*, and allows it to slip through, whereupon, the winding-arm makes another revolution, and rewinds the spring. This action goes on perpetually, the spring being wound up at fixed intervals.

Thus the escape wheel is driven by a constant force, and the escapement is thus subjected to a constant driving pressure.

FIG. 63.



This invention is very valuable, especially for turret clocks. For it enables a heavy weight to be put on the train, so as effectively to drive the hands in spite of heavy winds, while, at the same time, the pressure on the train is not felt at the escape wheel, which only gets so much pressure as the spring transmits to it, the rest being spent on a blow of the arm on the locking arrangement. Of course, such a clock requires more force to drive it, but the force that is employed in actuating the pendulum is always uniform.

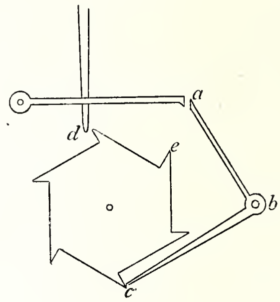
All sorts of forms of remontoir have been tried; some that unlock the driving wheels at every oscillation of the pendulum, some that operate only every half minute. They are a valuable aid to the clockmaker.

A remontoir escapement of this form was proposed by Sir George Airey, and has been going for nearly half a century in Dent's shop, in Cockspur-street. It is on the principle of a wind up every other second. It is operated by a pair of anchors, one of a dead-beat character, on the escape wheel, the other an unlocking anchor, operating the wheels which winds up the spring.

I now come to escapements of a different order, namely, detached escapements. These were first proposed for watches, and apparently by Peter Le Roy, about 1748. This form of escapement was perfected by Arnold and Earnshaw in the latter half of the eighteenth century, and now forms what is known as the chronometer escapement—the most perfect form of escapement in existence. The idea of this escapement may be thus explained.

The object is to give the impulse to the pendulum or the escape wheel at the middle point of its path, and to leave it perfectly free in both of its excursions. For this object we must provide the pendulum, or balance wheel, or the crutch, as the case may be, with a sort of arm or catch, as this flies by, as soon as it arrives at a given point of its path, an impulse-giving body flies out and leaps upon it and gives it a push of a definite amount and duration, and then slips out of the way so as to let it go back. The push, therefore, operates once only during each double vibration. It is like the action of a man swinging a child in a swing, who, standing in the middle of the path of the swing gives the child a push as he flies past. One of the very simplest and the best modes of doing this for a clock, was proposed by a clockmaker in the eighteenth century, whose name is not known. It is as shown in the adjoining diagram:—

FIG. 64.



There, as the pendulum swings, a catch upon it hits the point *a* of the lever, *a*, *b*, *c*, the tooth at *c* of the six-leaved escape wheel is released, and the wheel flies forward. The adjustment is so made, that at that instant the catch, *d*, is just opposite the tooth, *e*, which flies against it and gives the pendulum an impulse. If we compare this with Berthoud's watch escapement we see at once its great similarity.

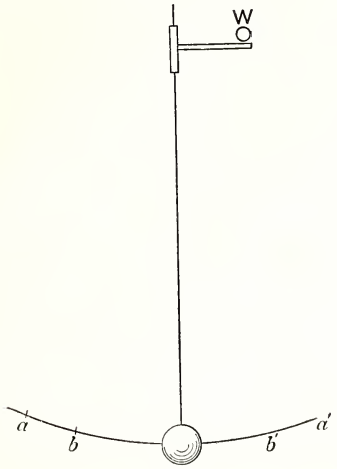
Of course the effect of this escapement is good upon time-keeping. For, as the impulse is given in the centre of the path, the swing of the pendulum, being free at each end, the disturbance of time due to the escapement impulse is a minimum. The chief defect of this escapement is the fine adjustment necessary to make the teeth of the escape wheel leap upon the arm of the pendulum.

In the case of a watch chronometer escapement this difficulty does not arise, for the radius of the balance wheel is short, and therefore moves in a curved arc, that admits of an easy engagement and release.

The remontoir principle, pushed to its uttermost extent, ends in a gravity escapement.

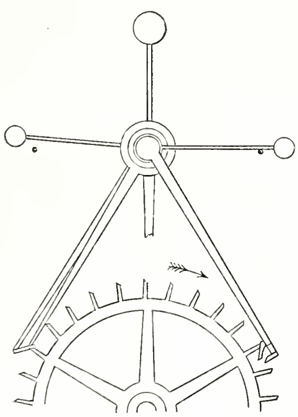
By this plan, an arm is raised by the motive force, and then allowed to drop gently on the pendulum, and give it a push. In this form of escapement we must have some means of winding the arm up at every oscillation of the pendulum.

FIG. 65.



Thus, for example, if we could fix an arm to the upper end of a pendulum rod, and then, as the rod swings, from *b'* to *b*, could put a little weight on the arm, and then take it off while the pendulum swings from *b* to *b'*, it is obvious that we should have a gravity

FIG. 66.



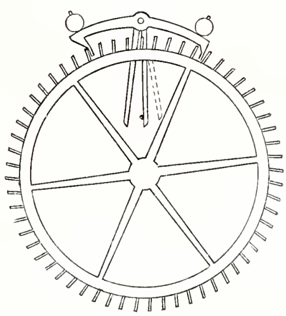
escapement. The first of these was proposed by Cummings. The adjoining sketch of it wiil show its nature.

Rigidly fixed to the crutch are two locking pins, which hold the teeth of the escape wheel alternately. The teeth of the escape wheel not only impinge on the locking pins, but also drive up two independent pallets which are held in position, when driven up, until the tooth which holds them is released by the swing of the pendulum. They are then caught on the crutch, go up to the extreme of its arc with it, and then fall to a position lower than the point from which they started, thus giving the impulse to the pendulum.

This is really a gravity escapement of a rather complicated, but perfectly effective form, and is probably the first proposal of that kind that exists. It will be seen that it can be simplified by suppressing the locking arms and pins altogether, and instead putting a small hook on to the ends of the pallets, which would thus lock the escape wheel and hold it, until the swing of the pendulum had brought this crutch with its pins into contact with the pallets and thus unlocked them.

This converts the invention into Mudges escapement, which is shewn here. (Fig. 67.)

FIG. 67.



It will be seen that the teeth of the escape wheel raise each of the impulse arms in succession until the tail is caught and locked; when the pendulum comes it unlocks the impulse arm and carries it onward to the extent of its vibration. This sets the escape wheel free to wind up the other impulse arm. Meantime the first impulse arm descends with the pendulum, but to a lower position than before, for its extremity penetrates in between the teeth of the escape wheel. Thus the impulse arm gives back more energy than it takes.

In his book, Lord Grimthorpe complains of the escapement that it trips. This complaint appears to me to be quite unfounded. I have made one which never tripped, and one has been going, and is going still, in Dent's shop, in Cockspur-street, for some 80 years, and yet has never tripped at all.

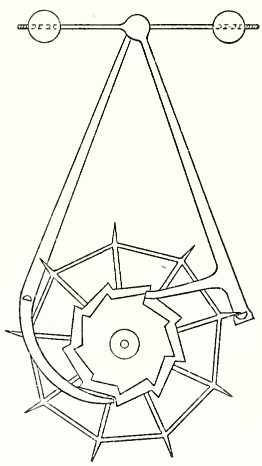
The true defect of the escapement is of quite another order, it is the work thrown upon the clock in the action of unlocking the escapement. This may amount to even one-sixth of

the whole driving force, and is very embarrassing, for it varies with every change in the friction, and hence with every state of the oil.

Of course, the more the train of the clock is loaded, the greater the pressure will be. So that this escapement presents the peculiarity that the greater the driving weight, the smaller the arc of oscillation of the pendulum. For the gravitational impulse is invariable, while the friction of the release varies. Hence then, you have here no compensating action, as in Graham's escapement. You have a uniform driving force, balanced against a variable unlocking force, and the escapement does not go very well.

About 1850, Mr. Bloxam, a barrister, of scientific attainments, set to work to remedy this defect. He did this by a means, at

Fig. 68.



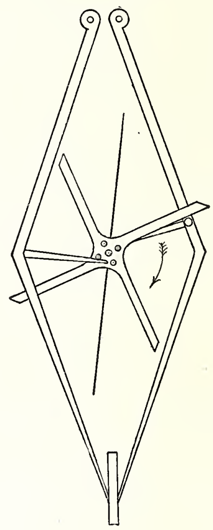
once obvious and simple. He applied to the escapement of Mudge the already described duplex escapement. Following this plan he separated the driving teeth of the escape wheel from the locking teeth, putting the former close in to the shaft, and the latter far away, and dividing each pallet into two parts.

This gave him the design shewn here. (Fig. 68.) He had feeble health, and died in Madeira, but not before he had made a successful clock on these principles, and published two most valuable memoirs on the theory of escapements and on pendulums. He also invented the dipleidoscope.

About this time Sir Edmund Becket Denison (afterwards Lord Grimthorpe) interested himself in clocks, and to him was due the fact that the contract for the Westminster clock was given to Dent instead of to Vulliamy.

He adopted the escapement of Bloxam. As, however, this escapement was found to bang and rebound, he put a fly on it, a device that had previously been used in connection with escapements, and thenceforth called it the Denison escapement.

Fig. 69.



The mode of action, as will be seen, is that the pendulum unlocks the impulse arm on one side and carries it up with it upon its excursion. This frees the escape wheel, which at once winds up the impulse arm on the other side. The impulse arm is then locked by the long locking tooth, and held steady. Meantime, the impulse arm, which is resting on the pendulum, comes down to a position lower than it had when it started, and thus drives the clock. Thus, then, we see that the application of the duplex principle to Mudge's escapement produced Bloxam's escapement, and that this is really Denison's.

For turret clocks Bloxam's escapements has been used for many years, and with a considerable amount of success. I am, however, inclined to the opinion that it is preferable to use a dead-beat escapement for turret clocks, and to cover it with a glass if the dial is not above four feet diameter. This will effectually keep out wind and rain, and relieve strain on the hands, which should, of course, be carefully balanced. Plate glass is now so good and cheap that this plan does not offer difficulty, nor does there appear to be any danger in it. With all gravity escapements the power employed is, of course, far in excess of the power necessary to drive the clock.

It may be of interest here to inquire what

that power is. In order to examine this, I pulled aside a lead pendulum bob, weighing 8 kilogrammes, to a distance of 4 centimetres. At the end of 1080 swings (single vibrations) it had diminished to 3 c. semi-arc, and this had lost $1 - \frac{9}{16} = \frac{7}{16}$ of its energy. The energy originally in it $= 8000\ h$ gramme-centimetres when $h = \frac{16}{209} = \cdot 08$ c. So that the energy lost in each single swing was $\frac{7 \times 640}{16 \times 1080} = \cdot 319$ gramme-centimetres. Thus to keep a clock swinging, with a bob of about 18 lbs., and a semi-arc of 3·5 cm. for 8 days, you want $8 \times 86400 \times \cdot 319 = 230784$ gramme-centimetres, or 2·2 kilogramme-metres, corresponding to the fall of a weight of about 2 lbs. through 5 feet in each 8 days.

The friction of a fine Graham escapement, with jewelled holes and pallets, caused about as much loss of work as is lost by air friction on the pendulum, thus requiring about a 4 lb. weight, and expending 250 kilogramme-metres of energy in a year. An astronomical gravity escapement would use about eight times as much energy.

The Denison escapement is not well suited for astronomical clocks, because the pendulum is never quite detached, and because the oil on the pallets cause considerable variations of friction. From all I can learn, it is not nearly so good as a well-constructed Graham.

In order to profit by the advantages of a detached pendulum, and at the same time to keep the impulse to the centre of the arc, and make it uniform, I devised an escapement which runs quite free of oil. It is best driven by electrical power, and to that end Mr. Hope-Jones' electrical lifter seems best adapted to the purpose.

I do not propose to say anything about striking mechanism, nor magical clocks, nor of the well-known apparatus for providing the driving force while the clock is being wound.

I think, however, that it is a great pity that ball bearings are not applied to turret clocks. If made to run in troughs of heavy grease they would work for years. Only the heavily-loaded bearings need thus be mounted, but the saving of the driving weight would be very considerable and the wear much diminished.

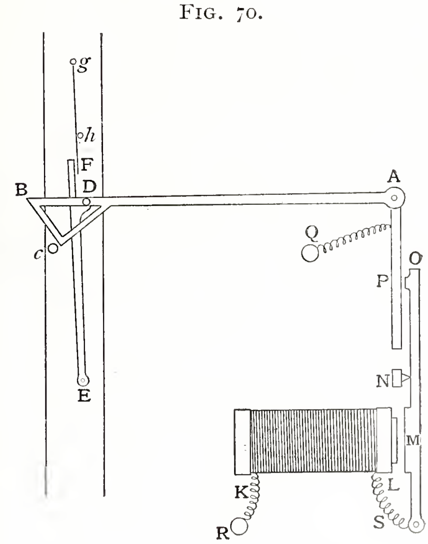
It was originally no part of my purpose to deal with electrical clocks which demand a series of lectures for themselves. A few words about them may, however, not be out of place. As was said in the opening lecture they may be divided into several groups.

Of them the simplest is an arrangement of an iron armature attached to the pendulum bob, and attracted by a magnet. The usual plan of later forms of this type is to let the armature penetrate into a solenoidal magnet. The reasons for the adoption of this form are that the pull is more gradual, and also because if the rod that forms the armature is a little out of position, in this solenoid the pull is unaffected, whereas if the armature is attracted by an ordinary magnet the slightest variation in its distance from the armature makes a considerable difference in the impulse. An effective clock of this type can be made by attaching a contact piece to the pendulum rod in such a way that contact is only made when the pendulum is proceeding from right to left, so as to give an impulse every other swing.

The defect of all this class of clocks is that the impulse varies with the current-strength. To avoid this, attempts have been made to make the current draw up an armature which by its fall produces a current in the magnet that attracts the pendulum, thus producing a sort of electrical remontoir.

Another class, which I may call the electro-mechanical group, is that of clocks wound up by electricity when they have run down. This of course is easy to arrange by means of contacts that come into play on the running down of the clock and continue till the re-winding has been completed.

FIG. 70.



A specimen of this type is a remontoir that I have proposed and made, consisting of an arm furnished at the end with a triangle of metal, which falls on a pin put upon the lower part of the pendulum rod and gives it a push. The arm is held up by a pall, which is released

as the pendulum flies by by the action of a spring fastened to the rod. The figure will show the action. A B is the arm which falls upon the pin *c* attached to the pendulum rod, and gives it an impulse from right to left. The arm A B is prevented from falling by the catch E D F, which is knocked astride by the spring *g* on the pendulum rod, which rests against the stop *h*, also on the pendulum rod. When the arm has done its work a projection from it, P, impinges on O, a platinum point on the end of an arm S O, this completes an electrical current through an electro-magnet K L, and causes the arm S O to be attracted and thus to drive up the arm A B till the pin D again rests on the catch E F and holds the arm up. On the return of the pendulum, the spring *g* flips by without causing any action, but on its return it again engages the arm E F, releases the arm H B, which thus gives an impulse every second vibration. The electrical part of this escapement is an adaptation of Mr. Hope Jones' electrical escapement. The advantages are that it works without oil, that it is dead beat, that it is detached, only operates during the point of maximum motion of the pendulum. and is a gravity escapement independent of the electrical impulse. I have constructed several of them, and they appear satisfactory.

Doubts have been expressed as to the reliability of electrical contacts for clocks. I have, however, never found any difficulty or uncertainty with them provided they were constructed on proper principles. Those that fail generally do so because the contact is too light and the surface is not rubbed. I believe that some form of electro-mechanical clock will be the clock of the future.

Another plan that has been proposed is by means of a powerful weight wound up every week or so, to drive a dynamo at certain intervals, say every minute, and thus to send a current through a circuit. This plan has the advantage of having no contents to get out of order, but it is wasteful of power and the initial expenditure is rather large, but it can be made to work well.

I regret that the space at my disposal has not enabled me to deal in detail with various sorts of electrical clocks, a collection of which are here before you. I feel, however, that the whole question of electrical horology is in a state of transition, and that before many years are passed some types of a permanent order will emerge out of the present multiplicity of proposed devices.

FIGURE IN WOOD.

By Frank Tiffany.

Possibly one of the least-considered phases in the growth of timber is that of figure. Whilst the expert and the enthusiast dilate upon the beauty of colour and figure found in some logs, few consider the origin, cause, and development of this beautifying factor, which gives an added charm and also a special value to timber. Those who look for a scientific explanation as to the cause of the variation of grain which is the cause of figure when the tree is cut into, will no doubt be disappointed to learn that it is impossible to lay down any set of rules which govern the accentuation and development of figure in wood.

It, however, may be safe to affirm that there are two primary causes which tend to bring about this peculiarity of forest products, and which undoubtedly increases the beauty of woods. Figure, in some woods, is "inherent," for this no explanation is possible. It will no doubt be a surprise to many to learn that the greatest variety of, and the most beautiful forms of figure in wood, arise from "foreign causes," and are therefore "accidental." In some cases both the "inherent" and "accidental" factors combine, and form a picture of nature which no artist can reproduce.

It may be stated in passing that the greatest charm in wood is found where there is a happy combination of figure, colour, and texture; thus, the richly-figured piece, if it lacks a proper variety of colour, or a silky texture, it is insipid, and does not command the value which experts attach to those rare examples which combine the three essential characteristics, "colour," "figure," and "texture."

Having stated these initial facts, it may be an advantage to offer some explanation so as to enable the reader to distinguish that which is "inherent" from that which is "accidental."

Inherent figure is found in those trees whose transverse section shows a series of fine "silver lines," scientifically described as "medullary rays." These radiate from the centre or pith of the tree to its circumference. The oak, beech, and sycamore are striking examples of this characteristic in timber. Of course there are many trees of commerce which in a greater or less degree show these rays, but the beauty or charm of figure is when

it is apparent to the naked eye without the aid of a microscope.

In the conversion of timber where the medullary rays exist, in order to obtain the best effects and bring out the figure, it is necessary to cut the boards on the quarter, that is from the centre to the outer edge. If the wood is cut across the diameter the figure will not show on the face; and in oak especially, there is a pronounced tendency for the surface to check where the rays cross through the thickness of the board.

Accidental Figure.—The use of this term should be accepted in its widest sense ; as any accident, from whatever cause, which aids the formation of a bulbous accretion of matter, is not inherent, but foreign.

It should be noted that these foreign causes effect and give a charm and beauty of appearance to the wood, and also increase its value when required or used for decorative purposes, yet, on the other hand, in timber required for structural purposes, where the straightness of grain is the first essential, these accidents of growth cause defects which reduce its commercial value. During the lifetime of a tree, there are so many contingencies and chances of accident, which may kill or may tend to divert its growth from a cylindrical sphere (which is natural to a tree), and any deviation from this in a young sappling leads to a variation of fibre. This becomes accentuated as the tree attains maturity.

What then are the accidents to the growth of a tree, which ultimately produce such pleasing effects? It would be difficult to give a complete list, but the following will indicate some of the possibilities :—

"Exposure," especially at high altitudes, or in a wind-swept valley. In the latter the tree catches, possibly, the strong winds on one side only; thus the stress and strain of weather, with perhaps the sun beating fiercely on one side, whilst the other side of the tree may be protected by a high hill both from wind and sun. All these circumstances are factors which tend to determine the form of growth ; thus a sapling gets a twist affecting a curvature of the trunk in its vertical growth, or the twist may be of a spiral nature, and as the tree grows these deviations become more pronounced, and are aided by the indurating action of the cellular and vascular tissues. It is generally admitted that trees grown in the centre of a forest yield straighter grained timber than those grown on the outskirts, or those which are hedge-grown.

Other factors tending to produce causes which result in the development of figures are the lopping of, or the breaking off of branches, the fracture being afterwards overlaid with annular layers.

One tree may fall against another and cause some abrasion of the bark, an abrasion may also happen by the action of wild beasts and cattle, either by accident or when the animals are in search of subsistence; in any case the cause is distinctly "accidental." Whilst the accident is not necessary to the well-being of the tree, the results if not too serious, are contributory to the development of the figure, possibly in the form of an excrescence.

Another form of accidental figure is to be found in maple, technically known as bird's-eye figure, which grows on trees botanically the same as the plain maple, the cause of the peculiar figure found in the former, is attributed by some authorities to the action of birds pecking at the bark for the saccharine properties of the wood. This illustrates the fact that the figure arises from accidental causes, although properties which attract the birds in search of subsistence are inherent, the action of the birds is not necessary for the tree's growth and well-being, but the result is that the timber gains a beauty of figure and form which it would not attain without the foreign aid of the birds.

Another form of figure which may properly be termed accidental is found on timber where the place of growth is liable to sudden variations of temperature. A spell of warm weather causes the sap to ascend the tree, but before it attains the full length of the trunk, a sharp spell of cold may set in, and check the flow of moisture. This process repeated annually for one or two centuries gives an enlarged butt and causes an irregularity to the fibre. In districts where the seasons are sharply defined there is a clear distinction between the summer and the winter accretions of woody matter, but this does not necessarily yield a figure possessing any intrinsic value.

It must not be understood that the figure known as "curls" is to be classed as "accidental," as the curls are found in that portion of the tree where the major stem branches out from the centre or main pith, and forms two distinct hearts. The intervening matter lying between the two hearts constitutes the curl or feather growth, hence the result is "inherent," although the beauty may be, and often is, accentuated by accidental causes.

It is a question whether to place the burrs of the Italian and Circassian walnut and similar woods amongst the accidental forms of figure. It is probable that they are a combination of the two causes, inherent and accidental. Where the burr is formed by an excrescence or wart it is distinctly accidental, but if formed at the base of the trunk, in conjunction with the roots, then both causes operate, as even a boulder may tend to form contortions of fibre, resulting in figure. The gnarled oak is largely the outcome of foreign causes, accentuated by centuries of the overgrowth of annular layers over a broken or irregular surface. The beautiful figure occasionally found in pitch pine is thought to be the outcome of foreign causes, as the figure is rarely more than a mere crust on the outer growth of the tree.

The figure found in Amboyna thuya, and sequoia, also the yew, is no doubt largely the outcome of accidental causes, each wood possessing its own distinctive characteristics; likewise the beautiful cross-grained "bruyera" of the Mediterranean littoral, from which the genuine briar wood pipes are made.

Terms of Figure. — Technical terms of figure are extremely varied. "Medullary rays," or silver grain, has already been explained.

"Curls" are found in all trees, but possibly those of the mahogany possess the greatest intrinsic value, which probably arises from the fact of their frequent combination of texture and variety of colour. In many woods, the curls are unmerchantable as timber, and are frequently used in the production of charcoal. The cause of the formation of the curl has been given. The above types of figure are decidedly inherent.

Amongst the accidental forms of figure, which are frequently so profuse in mahogany and satinwood, and occasionally in teak and walnut, may be mentioned :—

Roe, which is formed by alternate streaks, or flakes of light and shade running, with the grain, from end to end of the log. If the roe is regular in size, and unbroken, it is little thought of; but if the flake be broad, and the light and dark parts blend yet strongly contrast, and are variedly broken in contour, the timber is greatly valued.

Mottle is that mark in wood which, when polished, appears like something raised on the surface. Mottle frequently varies in form, and many names are used to distinguish their varieties. Usually mottled figure commands higher prices than the wood in which the figure is merely a roe.

Stop Mottle arises from the angular grain running across the surface, and in broad flashes, frequently diverging from a point, like a bird's foot. Where logs possess a combination of broken roe, mottle, and stop mottle—along with a silky texture and good colour, not necessarily too pronounced—they command a high value; especially if the wood is free from inherent or foreign defects.

Fiddle Mottle runs in nearly even streaks, as seen on fiddle-backs; but usually this figure lacks the richness and variety of colour.

Plum Figure and *Peacock Mottle* are also terms applied to figure, but they do not call for any specific notice. Rosewood, kingwood, and zebra wood have each their special type of figure. Birch is occasionally found with a wavy figure running across from edge to edge.

The art of obtaining the best results, when converting figured timber, depends upon the expert; and it would serve no purpose to lay down any set rules; but in cutting wainscot oak it will be found, as previously explained, as a general rule, that it is best to cut the wood in a line, from the centre to the outer diameter. The conversion of gnarled timber must, however, depend upon the judgment of the expert.

In mahogany the figure is usually more pronounced as one gets nearer to the centre, unless it be in the St. Domingo variety, the figure of which is a mere crust on the outside; the same remarks apply to pitch pine. In maple especially the most beautiful sheets of veneer are obtained by peeling the log with the knife cutter in the lathe. To cut across a maple log usually shews figured edges and a plain centre.

It may be stated that each different species of wood possesses, in a greater or less degree, figure, either accidental or inherent, generally peculiar to itself. This, along with its formation of structural fibre, colour, and texture, enables the expert to determine its identity; but the types of figure enumerated of the few leading woods will afford one of the most delightful studies in connection with timber generally, be it grown either in the temperate or tropical zone. In furniture making and exterior fittings generally there is room for a better appreciation of the charms of figure in wood.

TRADE IN SOUTHERN ITALY IN 1907.

The region covered by this report (that of Mr. Consul-General Neville-Rolfe) includes Naples and other Mediterranean ports such as Castellamare, Gaeta, Pozzuoli, Torre Annunziata, Salerno, &c., as well as Bari, Barletta and Monopoli on the Adriatic side. The aggregate population of the district is about 9,000,000, of which about 800 are British.

On the whole, 1907 will hold its place as a satisfactory year. The returns issued by the principal banks shewed excellent results. British shipping, though hard hit on the passenger side, owing to the temporary decrease in emigration and the slackness of Trans-Atlantic tourist trade, showed an increase of 56 ships cleared, with an increase of 173,586 tonnage, over the figures for the previous year. The ships and tonnage entered were rather less. The exports of olive oil in 1907 were lower than that of any of the preceding five years, the bulk of the produce being absorbed by the local markets, other oil-producing countries having no surplus for export. The prices were extraordinarily inflated at the close of 1907, but as the last crop has been exceptionally fine, including the yield in Spain, Crete, and the Levant, it is anticipated that prices will weaken.

A new law has been passed regulating the hours of labour of women and children in industrial occupations. No child under twelve of either sex may be employed in any factory, and in the case of mines and other dangerous occupations, no boy under 15 or woman under 21 may be employed. Children must be certified as medically fit and also as having passed the requisite educational standard.

Great efforts have been made to promote emigration to Brazil, the trade of which is developing substantially.

Improvements are about to be carried out in the manufacture of salt, which is a Government monopoly of great value. The humblest peasants are affected by the impost, and even those in the coast villages who use the sea-water, have to pay a tax for it. Hitherto the brine, whether from the saline springs or from the ocean, has been simply run into pans and evaporated, but with improved methods and proper machinery many thousands of tons more will be produced than at present, and Italy will become, so it is anticipated, an exporter of salt. Lower prices are much needed, salt being about seven times as dear in Italy as in the United Kingdom.

A prize competition for the best machine for extracting essence of lemons and bergamot will be held at Rome in the course of the year 1909, the principal prize being a money award of £400. In regard to railway rolling stock, extensive orders for locomotives were given to German, Russian, and Italian firms at prices varying between 6½d. and 7½d. per pound. The prices of the railway carriages ranged from £1,560 and £2,104.

The Italian United Chamber of Marine Commerce has passed a unanimous vote for the establishment of a line of large 15 knot steamers from Italy to Australia the intention being to initiate a substantial export of fruit and garden produce from the former country. A weekly service has quite recently been started between Naples and Malta, calling at Messina and Reggio.

In regard to the export of Italian textiles to Egypt good business is being done, the value of those sent from Italy being four times that of the goods from France. The Italian goods which have the pre-eminence are flannelette, cotton, Italian cloth, and stuffs for covering furniture. In jute textiles, Italy is outstripping the United Kingdom as well as France in the Egyptian market.

IRRIGATION PROJECTS IN MESOPOTAMIA.

It is announced that Sir William Willcocks has been appointed by the Turkish Government to supervise the contemplated irrigation and canalisation works in Mesopotamia and elsewhere The *Times of India*, in commenting on the news, says it is difficult to write of the economic and trade prospects which will thereby be opened up without apparent exaggeration. In the epochs of the Assyrian and Sassanian kings, the lower lands traversed by the Tigris and Euphrates were one of the chief granaries of the world, and Herodotus wrote in enthusiastic terms of their fruitfulness. The wealth of these ancient kingdoms was derived from agriculture, which again depended on extensive works of irrigation, covering vast tracts of country. The destruction of the Sassanian rule by the Arabs, and the desertion of its ancient bed by the main stream of the Tigris, cut off the supply of the mighty canals (there were 35 in the Babylonian district), and the Persian nobles and landlords were powerless to repair the dykes. Nevertheless, there appears to be good ground for the expectation that money, brains, and labour will achieve as good results by irrigation in Mesopotamia as in India and Egypt. On the basis of surveys made in the winter of 1904-5, Sir W. Willcocks estimates that by an expenditure of £8,000,000 sterling a million and a quarter acres can be irrigated on the Tigris alone, while in Lower Chaldæa there are a million and a half acres awaiting reclamation, giving an estimated return of twenty millions for an expenditure of thirteen. There are no serious engineering difficulties to be encountered. the slope of the land providing a natural line for the irrigation canals. The first work is a combined irrigation and navigation canal, connecting the Euphrates and Tigris, near Baghdad, after which the whole scheme automatically divides itself into blocks, each one of which can be carried out independently, and all forming a co-ordinate whole. The capital cost of the scheme is over 20,000,000 sterling, which, the *Times of India* anticipates, will be available in instalments, and from the expenditure of which India

herself should benefit largely. Of this latter point there can be no reasonable doubt; the great question is, will the money be forthcoming, and will it be rigidly allocated and honestly spent in the undertaking? The dawn of Turkish renaissance promises well for the project; it is, however, a gigantic one, and bound to be spread over a considerable period of time. On the other hand, the completion of the Hejaz Railway from Damascus to Medina is a most encouraging proof of what Turkish enterprise is capable of, unaided, under a reformed administration, and the progress of the new undertaking will certainly be watched with sympathetic interest.

SUGAR PRODUCTION IN FORMOSA.

It seems likely that sugar cultivation will be largely extended in South Formosa. With a proper system of irrigation, capable of utilising the abundant supply of land water available, the region would be an ideal one for such cultivation. What is wanted now that there are many large factories in the island, is the more scientific cultivation of the cane by deeper ploughing of the lands with the help of steam ploughs, and the acquirement of better knowledge of the use of artificial fertilisers for the varied soils. One circumstance, much in favour of sugar cultivation, is that the rains are, as a rule, evenly distributed, and come and stop at the right time. During the Chinese *régime*, Formosa produced from 60,000 to 80,000 tons of brown sugar per annum, of which from 45,000 to 50,000 tons were exported. The experience of the British firm in the district allotted to them, says Mr. Consul Wileman, in his report on the trade of Formosa, just issued (No. 4083, Annual Series), would appear to indicate that by planting new and better cane, and by encouraging farmers to take up more land, the yield could be trebled, and there is no reason why Formosa should not produce in the immediate future (say within the next five years), 200,000 to 240,000 tons of sugar per annum. The old style sugar was valued at 4 yen per picul, say £7 per ton, so that the value was £420,000 to £560,000 per annum, from which the Chinese Government obtained a duty of 18 c. (4½d.) per picul, or 6s. per ton. As a result of the encouragement which the Formosan Government has given to the industry, not only will the yield be trebled, but the value has been considerably increased. Sugars, as produced by these modern factories, are worth 14 yen (£1 9s. 2d.) per picul in Japan, or 13 yen (£1 7s. 1d.) per picul in Formosa. Thus the yield by the land from this industry alone will be increased eventually from between £420,000 and £560,000 to between £4,400,000 and £5,200,000, and the yield in taxes to the Government will be £1,000,000 to £1,200,000, almost enough to meet the ordinary expenditure of the island. The consumption in Japan exceeds 225,000 lbs., so that even when the industry is fully developed in Formosa the yield will all be taken by Japan.

HOME INDUSTRIES.

The Effect of the Patents Act.—Reference has been made more than once in these Notes to the number of new factories being built in England in order to protect the British patent rights of foreign manufacturers. Considerable extra employment has been and will be afforded to British labour by these factories, but there has been some exaggeration in the Press as to its extent. The following list is believed to comprise most of the important arrangements that have yet been made as a result of the new Patents Act:—The Badische-Elberfelder colour factory at Port Sunlight, and the Hïrchstur Farbwerke colour factory at Ellesmere Port; the British Glauzstoff Manufacturing Company, artificial silk factory, Liverpool; the Chemische Fabrik Schering, in the neighbourhood of London; the Imperial Works, Brinsdown, Essex (Wolfram electric lamps); the Sanatogen Food Company, Hayle, Cornwall, and the Deutsche Waffen and Munitions Fabriken, of Berlin (arms and ammunition); the Gillet Razor Company (safety razors), Leicester; the United Shoe Machinery Company, Leicester; British Suction Gas Plant Company, London; National Cash Register Company, London; Clinton Wire Cloth Company, Cheshire; Buffalo Speciality Company, London; Flotman Drill Company, Cardiff; and the Zunwir Conveyor Company (in conjunction with the Wantage Engineering Company). In addition, it is reported that a syndicate of foreign patent holders has been formed to establish joint factories in England, where the various patented articles are to be manufactured on a profit-pooling system.

Electric Lighting in Glasgow.—The Electricity Department of the Glasgow Corporation have just published their accounts for the financial year 1907-8. The total capital expenditure up to the end of the year was £1,685,084, or £62·4 per kilowatt capacity of plant installed. When it is remembered that a large turbo-generating set can be purchased for less than £5 per kilowatt of capacity it will be understood that the engine and generator are not the only items in an electrical scheme. The principal items of capital expenditure include land and buildings, which account for £227,698, or 13·47 per cent. of the total; mains and cables account for 53·48 per cent.; and machinery and plant for 28·78 per cent. These figures do not include the generating stations for tramway power, which are kept distinct from the light and power stations. The average receipts per unit were 1·854d., and were expended as follows:—0·49d. for generating costs, 0·109 for distribution costs, and 0·245 for management (including rent, rates, and taxes), and 1·003d. for capital charges, leaving a balance of 0·007d. It will be noted that the capital charges amount to more than half the gross cost of production, and are three times as large as the fuel costs.

The Coal Trade.—In the eight months ended August the exports of coal were less by 282,000 tons,

though higher in value by £1,350,000, as compared with the corresponding period of last year. Having regard to the exceptional character of last year's coal exports, and the general industrial situation, the shrinkage in exports is surprisingly small, nor has it been from all the centres. Indeed, the shipments from the Scotch ports fell off more than the whole sum of decrease. Welsh shipments have been kept up by the demands of Italy, and one or two other countries in which Welsh coal holds a commanding position, the exports to Italy in the eight months to August last having been 5,792,345 tons, as against 5,703,534 tons last year. In Scotland, while exports are falling off, there is no recovery in the home industrial consumption. English coal is still relatively dear, which hampers many industries. The sustained exports have prevented home coal prices from declining more, in harmony with the industrial conditions, but with a continuance in the decrease of the demand from abroad, and little likelihood of immediate improvement at home, it is difficult to see how present prices can be long maintained, though the coalowners say that even present prices, owing to wages and other costs, are unremunerative. Considerable discussion is going on in the trade just now on the subject of colliery certificates. Shippers obtain from the colliery whose coal they ship a certificate that such and such a quantity of such and such a specified coal has been shipped by such and such a vessel. But it is alleged that it is an everyday thing at all the coal ports for exporters to make up mixed cargoes, and get a document from some coal company certifying that the whole cargo is of the named brand. The allegation on the face of it seems improbable, and it may be hoped that it rests on slender or no foundation. In these days of German and other coal competition, it would be disastrous to British interests if it came to be believed by foreign consumers that the practice referred to was common.

The Coal Mines Bill.—The discussion as to whether the Coal Mines Bill now before Parliament for restricting the hours of labour in coal mines will seriously raise the price of coal, continues, and cannot be finally settled until there is the experience of actual working. It is contended by supporters of the Bill that the increase in price, if any, must be slight, but as Mr. J. F. Mason, M.P., points out, they are apt to confuse cost and price—the cost of producing coal and the price at which it is sold. The cost of bringing a ton of coal to the pit mouth is not the only thing, nor the chief thing, which affects price to the consumer. Reduction of output is a much more important matter. The late Sir George Livesey—and there was no higher authority on such a point—reminded the public that the price of certain classes of coal to the consumer (not the cost to the producer) rose, either "through shortage, or the fear of shortage" in the supply, by 9s. 6d. a ton in one period of two years (1898–1900), and by 14s. in another period of two years ("the early seventies"). Now the Departmental Committee recently reported that in its opinion the limitation of hours of labour proposed by the Coal Mines Bill would lead to a loss of time of about 10 per cent. It may be that increased activity on the part of the miner will make up for much of this loss of time, but it is doubtful whether the shorter hours will enable him to materially increase his output per hour, and if the reduced output is at all proportional to the 10 per cent. loss of time, then a shortage of some 25 million tons will be, if Mr. Mason's estimate is correct, unavoidable, and may create a scramble among those who must have coal in order to carry on their industries, or risk seeing them closed altogether. Such a scramble could hardly fail to produce a rise in price of a serious character.

The Cotton Trade Dispute.—There are no indications of an early settlement of the cotton strike. The card-room leaders appear to be immoveable, and the employers remain united in their insistence upon a 5 per cent. reduction. The mills, or most of them, have now been closed for six weeks and the prices of yarn do not rise. From the employers' point of view a continuance of the strike for another month or six weeks is desirable, and apparently the card-room people believe that it is to their interest greatly to restrict output during the next weeks rather than spread it over several months in the form of short time. In these circumstances it is not surprising that masters and men are slow to come to an agreement, but they do not seem sufficiently to appreciate that the strike may not stop just at the moment when the economic position makes it desirable to go ahead again, and that in the interval our competitive position in particular markets may be imperilled. Meantime some employers are taking advantage of the strike for repairs and alterations which can only be conveniently done when machinery is not working. Amongst such matters not the least important is the condition of the ceilings in mills of the non-fireproof type with regard more particularly to the fire hazard. Ceilings are frequently allowed to get into bad condition, and in mills where spinning is done, and the floors are not quite sound, the oily waste which accumulates in course of time between the floors and ceilings is in a favourable situation to feed flames reaching the ceilings from below.

OBITUARY.

Sir Charles Malcolm Kennedy, K.C.M.G., C.B.—The Society has lost, by the death on the 25th instant, at Exmouth, of Sir Charles Kennedy, a prominent member who, for many years, took an active part in its proceedings. He was elected in 1884, and was a Member of the Council from 1889 to 1891, and a Vice-President from 1892 to 1896, and

from 1898 to 1901. This office he filled at the time of his death. He was also Chairman of the Colonial Section from 1892 to 1902, and a member of the Royal Commission for the Chicago Exhibition of 1893. He read two papers before the Society, the first on "Colonies and Treaties" (Foreign and Colonial Section, March 5, 1895); and the second on "The Fiscal Problem" (December 2, 1903), for which he received the Society's silver medal. He was Chairman, at evening meetings, on several occasions, and a frequent attendant until he settled at Exmouth, on his retirement from the Foreign Office.

Sir Charles Kennedy was born in London, on October 12, 1831, the son of James Kennedy, M P., He was educated at Blundell's School, and at Caius College, Cambridge, where he took two first classes and two University prizes. He became a clerk in the Foreign Office in 1852, and was head of the Commercial Department from 1872 to 1893.

He was through life constantly engaged in special services abroad. His first deputation (1870-71) was to the Levant as president of a commission of inquiry into the Consular establishments. Afterwards he was British Commissioner in Paris in connection with the Treaty of Commerce and Navigation concluded with the newly-established French republic in 1872.

He was senior British delegate to the various international conferences on the protection of submarine cables, held in Paris from 1882 to 1886; and he represented Great Britain at a conference at the Hague for the restriction of the liquor traffic in the North Sea; and in the same capacity he subsequently took part in the negotiations in Paris respecting the Channel fisheries.

After his retirement Sir Charles Kennedy was lecturer on international law at University College, Bristol, from 1896 to 1903, and some of his lectures have been published. He was chairman of the Exmouth School Board from 1896 to 1903.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 2...Farmers' Club, Whitehall-rooms, Whitehall-place, S.W., 4 p.m. Prof. Somerville, "The Report of the Departmental Committee on Agricultural Education."

Geographical, University of London, Burlington-gardens, W., $8\frac{1}{2}$ p.m. Mr. D. G. Hogarth, "Unexplored Western Asia."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, in the Theatre of the United Service Institution, Whitehall, S.W., $7\frac{1}{2}$ p.m. Mr. R. W. A. Brewer, "The Flow of Liquid Fuel through Carburettor Nozzles."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. Prof. Adolf. Frank, "Chemical Industry in Relation to Agriculture."

British Architects, 9, Conduit-street, W., 8 p.m. Opening Address by the President.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. C. Carus-Wilson, "Underground Water Supply."

TUESDAY, Nov. 3...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Inaugural Address by the President (Mr. James C. Inglis).

East India Association, Caxton-hall, Westminster, S.W., 4 p.m. Dr. John Pullen, "The Indian Student in England."

WEDNESDAY, Nov. 4...Geological, Burlington-house, W., 8 p m. 1. Mr. Hugh John Llewellyn Beadnell, "The Relations of the Nubian Sandstone and the Crystalline Rocks of Egypt." 2. Mr. E. A. Newell Arber, "On the Fossil Plants of the Waldershare and Fredville Series of the Kent Coalfield."

United Service Institution, Whitehall, S.W., 3 p.m. Major Cecil B. Simonds, "With the Anglo-French Niger Chad Boundary Commission."

Royal Archæological Institution, 20, Hanover-square, W., $4\frac{1}{2}$ p.m. Mr. William Davidson, "Notes on Norfolk Screens and their Paintings."

THURSDAY, Nov. 5...Linnean, Burlington-house, W., 8 p.m. 1. Miss May Evalina Bainbridge, "Notes on some Parasitic Copepoda, with a description of a new species of *Chondracanthus*." 2. Messrs. R. C. Punnett and C. Forster, "On Some Nemerteans from the Eastern Indian Ocean." 3. Prof. F. Jeffrey Bell, "Report on the Echinoderms other than Holothurians, collected by Mr. Stanley Gardiner in the western parts of the Indian Ocean."

Chemical, Burlington-house, W., $8\frac{1}{2}$ p.m. 1. Messrs. W. A. Bone and H. F. Coward, "The Direct Union of Carbon and Hydrogen." 2. Messrs. E. C. C. Baly and W. B. Tuck, "The Relation between Absorption Spectra and Chemical Constitution." Part XI. "Some Aromatic Hydrocarbons." 3. Messrs. B. D. W. Duff and F. S. Kipping, "Organic Derivatives of Silicon." Part VII. "Synthesis of *di*-sulphobenzylethylisobutylsilicyl oxide." 4. Mr. W. J. Sell (*a*) "Chlorine Derivatives of Pyridine." Part IX. "Preparation and Orientation of the Dichlorodyrdine M.P. 66-70." (*b*) "Chlorine Derivatives of Pyridine." Part X. "Orientation of the Trichloropyridine." (*c*) "Chlorination of Methyl Derivatives of Pyridine" 2-Methyl Pyridine. Part II. 5. Messrs M. O. Foster and H. E. Fierz (*a*) "The Triazo-group." Part. V. "Resolution of *a*-triazopropionic Acid." (*b*) "The Triazo-group." Part VI. "Triazoethyl Alcohol and Triazoacetaldehyde."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Carl Armbruster, "The Songs of Robert Franz."

FRIDAY, Nov. 6...North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, $7\frac{1}{2}$ p.m. Inaugural Address by the President.

Art Workers' Guild, Clifford's Inn-hall, Fleet-street, E.C., 8 p.m. Paper on "The Difficulties of a Modern Artist."

Architectural Association, 18, Tufton-street, S.W., $7\frac{1}{2}$ p.m. Mr. Felix Clay, "The Origin of the Sense of Taste in Art."

Geologists' Association, University College, W.C., 8 p.m. Mr. Horace W. Monckton, "Some Norwegian Lakes and Rock-Basins."

Journal of the Royal Society of Arts

No. 2,920. VOL. LVI.

FRIDAY, NOVEMBER 6, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

SECTIONAL COMMITTEES.

The following is the list of the Colonial Section Committee, as appointed by the Council:—

COLONIAL SECTION COMMITTEE.

Sir William H. White, K.C.B., LL.D., D.Sc., F.R.S. (Chairman of the Council).
Sir Westby B. Perceval, K.C.M.G. (Chairman of the Committee).
Earl of Aberdeen, G.C.M.G.
Hon. Sir William Arbuckle, Agent-General for Natal.
Lord Belhaven and Stenton.
Thomas Jewell Bennett, C.I.E.
Lord Blyth.
Lord Brassey, G.C.B.
Byron Brenan, C.M.G.
Sir Thomas Fowell Buxton, Bart., G.C.M.G.
Hon. Sir John A. Cockburn, K.C.M.G.
T. A. Coghlan, I.S.O., Agent-General for New South Wales.
Captain R. Muirhead Collins, R.N., Representative of the Commonwealth of Australia in London.
H. Bertram Cox, C.B.
Edward Dent.
Right Hon. Sir Charles Wentworth Dilke, Bart , M.P.
Hon. Alfred Dobson, Agent-General for Tasmania.
Hon. Sir Charles W. Fremantle, K.C.B.
Sir Somerset R. French, K.C.M.G., Agent-General for the Cape of Good Hope.
Right Hon. Sir George Goldie, K.C.M.G., D.C.L., LL.D.
Robert Kaye Gray.
W. L. Griffith.
Sir John J. Grinlinton.
Sir Charles Augustus Hartley, K.C.M.G., M.Inst.C.E.
Sir Clement Lloyd Hill, K.C M.G., C.B., M.P.
Sir Francis J. S. Hopwood, K.C.B., K.C.M.G.
Hon. J. G. Jenkins.
Sir Alfred L. Jones, K.C.M.G.
Sir Nevile Lubbock, K.C.M.G., Chairman of the West India Committee.
Sir Charles Prestwood Lucas, K.C.M.G., C.B.
Sir E. Montague Nelson, K.C.M.G.
Sir Montagu F. Ommanney, G.C.M.G., K.C.B., I.S.O.
Sir Gilbert Parker, M.P.
Hon. Cornthwaite Hector Rason, Agent-General for Western Australia.
Hon. W. Pember Reeves.
Arthur H. Reid, F.R.I.B.A.
Viscount Ridley.
Right Hon. Sir Joseph West Ridgeway, G.C.B., G.C.M.G., K.C.S.I.
Alexander Siemens.
Sir John Smalman Smith, M.A.
Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C. Agent-General for the Transvaal.
Earl of Stamford.
Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., High Commissioner for the Dominion of Canada.
Sir Thomas Sutherland, G.C M.G.
Hon. J. W. Taverner, Agent-General for Victoria.
Carmichael Thomas.
Hon. Sir Horace Tozer, K.C.M.G., Agent-General for Queensland.
Sir William Hood Treacher, K.C.M.G.
Sir Charles Rivers Wilson, G.C.M.G., C.B.
Sir John Wolfe-Barry, K.C.B., F.R.S.
Sir Frederick Young, K.C.M.G.
S. Digby, C.I.E. (Secretary).

THE ANTIQUITY OF ORIENTAL CARPETS.

By Sir George Birdwood,
M.D., K.C.I.E., C.S.I., LL.D.

Ingens decorum omnium templum Mundus.
Senecæ Epistolæ, XC.

Introductory.

As I have in the present monograph to deal with the question of the origin of Oriental carpets, I will at once state that, having from my earliest childhood been familiarised with the entire range of the artistic handicrafts of Southern and Western Asia, and, for the last fifty years of my life, with every passage in classical literature relating to the sumptuary arts of antiquity, and having always been accustomed to interpret the whole life of the ancient pagan West by that of the modern, but still, for the greater part, pagan East, I have long since been led, by an overwhelming inference from the gradually accumulated special facts thus ever present to my mind, to the tentative conclusion that the sumptuary carpets now manufactured in Turkey, Persia, Central Asia, and India, are, in texture, design, and colouring, and indeed in every decorative detail and technical manipulation, essentially identical, in all their traditionary denominations, with the Oriental carpets known to the Greeks and Romans; and that,

through "the dark, backward, and abysm of time," no limit can be given, on this side of B.C. 5000, to the date of their origin in the Valley of the Nile, and by the banks of the Tigris and Euphrates.

I deliberately indicate Egypt first, and Chaldæa, or archaic Babylonia, with Assyria, second. Civilisation no doubt appeared in its initial Turanian aspects simultaneously in the Valleys of the Indus, the Ganges, the Tigris, and Euphrates, the Nile, and the Yang-tse-Kiang. But even in the protracted period of universal Turanian predominance it must have advanced more regularly in countries which, like Egypt and Mesopotamia, are exposed to an annual overflow from the rivers draining them, than in countries, like India and China, not subject to annual inundation. Its progress must also have been more rapid in the countries lying along the middle course of the immemorial overland route between the East and West, as Egypt and Mesopotamia do, than in those which mark the extreme limits of that trade, as do China and the countries of Southern and Western Europe; while it would reach its higher developments only in those countries where, all other conditions being favourable, the aboriginal populations, whether Turanian or Nigritian, gradually became mixed with immigrant Caucasian races, as with Hamites and Aryas (Japhetites) in India, and Semites, Hamites, and Aryas, in Mesopotamia and Egypt.

The Caucasian type of civilisation undoubtedly had its actual beginning in Chaldæa; or some whereon the shores of the Persian Gulf, between the Valley of the Tigris and Euphrates and the highlands of Kirman, along the tract of Susiana, and Persis or archaic Persia, corresponding with the modern Iranian provinces of Laristan, Fars, and Khuzistan; for Chaldæa was near to the fertile plains of the industrial, pre-Aryan, populations of India than Egypt was; and was the first point of exchange for the overland commerce between the Indian Ocean and the Mediterranean Sea. But civilisation became more broadly and fully developed in Egypt than in Chaldæa, and afterwards in Assyria and Babylonia; and while Chaldæa undoubtedly exerted an earlier, and at all times more direct, influence on the civilisation of the East, not only throughout Anterior Asia, but in India, and even, as Professor Terrien de Lacouperie has shown, in China, and in the end deeply affected, through Assyria and Phrygia, the arts of Greece, it was Egypt that from its cradle, and, for countless centuries, almost exclusively inspired the prehistoric civilisation of the West. If, therefore, civilisation did not positively originate in Egypt, it there first made itself manifest in the imposing sepulchres, temples, and palaces, and the innumerable necrological, ritualistic, and sumptuary manufactures dependent on them, that exercised so marked an effect on the technical and æsthetic arts of Etruria and Greece, and through them of Europe; and also on the architecture and handicrafts of Chaldæa, Assyria, and Babylonia, and through them, as well as more directly in the time of the Ptolemies, on the architecture and handicrafts of Aryan India. We cannot fix the date of the oldest pyramid in the Valley of the Nile later than about B.C. 5000; and for not less, at the lowest computation, than the 1700 years between B.C. 2700 and 1000, Egypt was a light, to lighten the world, the lofty lone Pharos in the outer darkness of the Neolithic night of Europe; and she continued to occupy this position of solitary supremacy in relation to the West, until the dawn of civilisation in the Valley of the Nile, grew, between B.C. 480-402 and B.C. 336-280, to the perfect day of Greece.

If these profound chronological retrospects are not yet fully appreciated in Europe, whose age, counting from the mythical foundation of Rome, B.C. 753, to the present day, falls far short of that of the combined Old (Memphian B.C. ? 5000-3100) and Middle (First Theban B.C. 3100-1700) Pharaonic Empires and barely equals that of the New Empire (Second Theban, B.C. 1700), when its term is extended beyond its overthrow by Alexander the Great, B.C. 332, to the Arab conquest of Northern Africa, A.D. 638-40: if, in short, we find it hard to believe that the history of the whole civilised world is but the sequel of, and relative to, that of Egypt, it is simply because of the inveteracy of the inherited prejudice of the West in dating its civilisation from the incipiency of the arts of Greece. But the first period of Egyptian greatness, under the Pharaohs who ruled at Memphis, and raised the pyramids, as also the second, under the Pharaohs who ruled from Thebes, and built the temples of Luxor and Karnac, had passed away long before Cecrops started from Sais in lower Egypt for Athens, or Danaus from Chemmis (now Akhmim) in Upper Egypt for Argos, or Cadmus had emigrated from Phœnicia to Thebes (Bœotia), or Pelops from Phrygia to Elis; and before the legendary "voyage of the Argonauts," and the expedition of "Seven against

Thebes," and "the flood of Deucalion," the son of Prometheus, the mythical author of Western civilisation; and the third period of Egyptian greatness, under the dynasties of the New Theban Empire, had reached its culmination, and was turning to its decline, when, through the lifting mists of the morning of history in the Mediterranean Sea, we for the first time discover, in the sunshine of Homer, the azure prows and ruddy sides ("cheeks") of the hollow war-ships of the bronze-mailed Greeks (Achæans), and their allies, fleeting as fast as oar and sail can bear them to the assiege of Troy; the earliest indication we possess, of any historical value, of the nascent international life of South-Eastern Europe.

It is about the same time that a distant sound, as of war chariots and horses in motion, is heard in the East, from beyond the Euphrates, the first presage of the rising power of Assyria, whose dogged rivalry for Empire with Egypt (B.C. 1271-607), transmitted in succession to Babylonia (B.C. 747-578), Achæmenian Persia (B.C. 559-331), and Greece (B.C. 500-332), at last brought the long, and often renewed glories of the Pharaohs to a full and not incongruous close (B.C. 332).

For in consequence of Alexandria, notwithstanding the competition of Seleucia, the capital of Western Asia, until superseded by Ctesiphon, becoming, under the Ptolemies B.C. 332—A.D. 30, the great focus of the trade between the Indian Ocean and the Mediterranean Sea, a trade it continued to attract under the Cæsars, notwithstanding the stronger competition of Ctesiphon,* A.D. 226-652, the industrial predominance of Egypt remained unshaken until the conquests of the Arabs, during the seventh century A.D., in Syria, Northern Africa, and Persia, followed by those of the Turks, and other Tartars, gradually broke up and destroyed the great historical trade, through Mesopotamia and Egypt, between the Mediterranean Sea and the Indian Ocean; and with the triumph of Christianity in the West, and of Islam in the East, brought antiquity to its final end in Europe, and over the greater part of Southern and Anterior Asia.

The rapid and exceptional development of the civilisation of Egypt, and the widespread influence it exercised, were the natural consequence of the unique geographical position of the country. Chaldæa commanded the Indian Ocean only, being 800 miles distant from the Mediterranean Sea. It thus lost the larger portion of the trade between the two seas; while not all the trade passing between Anterior and Farther Asia necessarily passed through Chaldæa; and in fact much of it crossed the Valley of the Tigris and Euphrates, more to the northward, through Assyria and Media. Chaldæa, therefore, although watered by a river subject to annual flooding, and lying much nearer than Egypt to India, must have always held its prosperity by a comparatiively precarious tenure; and the remark applies equally to Assyria and Babylonia. Egypt, on the other hand, is situated beside a narrow isthmus, uniting two vast continents, and separating two seas; and therefore the chief part of the trade between Asia and Africa, and between the Mediterranean Sea and the Indian Ocean, always in ancient times passed through Egypt; and for over 5,000 years that country took toll and tythe of it all. Dynasties rose and fell, and foreign invaders came and went, but the Nile in its regular ebb and flood, flowed on for ever; and until the Turkish conquest of Anterior Asia and Northern Africa, and the discovery of the ocean way to the Indies, round the Cape of Good Hope, the overland trade also ceaselessly flowed through the Valley of the Nile, the mid point of earth; and thus doubly and perennially enriched, the Egyptians were enabled, for from 40-50 centuries B.C., to fill the world with their manufactures, in the same proportionate profusion as Manchester and Sheffield and Birmingham are filling it now, and to cover their country with public works, which for magnitude and utility can only be compared with the Mont Cenis Tunnel, and the Suez Canal, the two greatest triumphs of the engineering enthusiasm and joint-stock enterprise of the nineteenth century A.D.

If also Egypt received some of the germs of its civilisation from primeval Chaldæa, they sprang up in the country to which they had been transplanted as if the indigenous growth of its own soil. The traditions of the Egyptians of their own origin were not associated with those of any other people; nor was their idiosyncratic civilisation connected with any other; whilst every other civilisation, both in the East and the West, is more or less related to that of Egypt. Every true alphabet is ultimately, in the greater number of its letters, of Egyptian origin; and if no link has yet been found between the gold and silver weights of Mesopo-

---

* Al Modayn, as the place was called by the Sassanians, included both Seleucia and Ctesephon, and was superseded, under the Arabs, by Kufa.

tamia and the still unintelligible meteorology of the ancient Egyptians, we may be sure that the progress of modern research is destined to demonstrate a close kindred between them; as also between the latter and the primitive copper weights and copper money of the oldest countries of Europe and Asia. Egypt was one of the sources of Greek science, and mythology, and the chief source of the refining and elevating elements in Greek art. The religion of the Jews was under obvious obligations to Egypt; and when the Egyptians, very much in consequence of their inherent belief in the immortality of the soul, whereon indeed the whole fabric of their civilisation was based, spontaneously accepted Christianity, the new religion received from them the leaven of the mysticism and puritanism that have ever since characterised it, in its prevailing ecclesiastical and popular forms; and which are the direct source of the unnatural repugnance shown by some Christian sectaries to the cultivation of the fine arts, the glorious issue of the polytheism of Greece, in its efforts to give expression to the instinctive Aryan tendency to humanism in religion, as opposed to the morbid, self-mortifying proclivities of the polytheism of Hamitic Egypt.

In view of the absolute priority and measureless duration of Pharaonic civilisation, it seems strange, at first sight, that there should be so little tangible evidence of the impulse the arts of the Old World must necessarily have received from Egypt, in comparison with the ubiquitous proofs of their obligations to Mesopotamia. We know that the Doric column, and possibly the core of the Corinthian "capital," came from Egypt, and that the Doric style in Greek art was generally affected by the intercourse of Greece with Egypt; and if the plastic fine art of Greece drew any inspiration from abroad, it was rather from the idealising art of Egypt, than from the grossly realising art of Mesopotamia. But beyond this the influence of Egypt on the existing arts of the world is very much a matter of presumption. That of Mesopotamia on the other hand is demonstrable by an immense induction of instances; for it has left its immutable impress, as fresh and sharp to day as when first imparted between four and five thousand years ago, on all the handicraft arts of the conservative East; while there is scarcely a conventional ornament in use in the ever-changeful West that cannot be unravelled from the modifications it may have undergone, whether from ignorant employment without reference to symbolism, or from the caprice of fashion, and traced back step by step, to its first, crude, allusive form, in Chaldæa and Assyria. In short, not only the Ionic column, but all that is Ionic in the arts of Greece, and in the derivative arts of Europe, originated in Mesopotamia.

A moment's reflection suggests the obvious explanation. The operative force of Egyptian civilisation for the 3,000 years before it joined hands, about the twentieth century B.C., with that of Mesopotamia, was chiefly spent, and, in a sense, spent in vain, on the pre-historic inhabitants of the Neolithic age in Europe. But the historical Aryan races were already extending themselves over Europe, and overspreading Persia and India, when the Chaldæans began, about the same time that they organised their commercial communications with Egypt, to navigate the Indian Ocean, and to plant their arts, under the shield of the Hittites, in Syria and Asia Minor; and thenceforth both India and Greece remained in almost constant communication with Mesopotamia; Greece, both intermediately through the Phœnicians, and immediately through the overland trade between the Persian Gulf and the Ægean Sea; until gradually all Anterior Asia, with Egypt and Upper India, and Greece, were made one with each other under the Hellenistic Empire of Alexander the Great, and the Diadochi, and Epigoni; and, afterward, excepting India and Persia, with Rome, under the Cæsars; the energetic West thus rendering back sevenfold into its bosom the harvest of the foreign seeds of technical culture originally brought from the East; the type which the Byzantine Greeks, in the service of the conquering Arabs, imposed on the Egypto-Mesopotamian building and decorative style of Anterior Asia, having survived to the present day as the so-called Saracenic art of Islam.

How far-reaching and fruitful were the direct Hellenising influences exerted by the conquests of the Macedonians is illustrated by the Græco-Buddhistic sculptures near Jellalabad, in Afghanistan, and near Peshawur, in the Punjab; and, although later in date, by the colossal strangely-mixed deities, Zeus-Oromazdes, Apollo-Mithras, and the like, discovered in 1882 on the summit of the Nimrud-Dagh, 6,500 feet above the level of the sea, and there raised, as the inscription on them state, for the adornment of the Græco-Persian (pre-Byzantine) tomb, prepared for himself by Antiochus I., who reigned over Commagene B.C. 69-34.

The generic identity of the universal industrial arts of the old democratic life of Asia and Europe is thus seen to be due chiefly to their being the immediate offspring of the Egypto-Mesopotamian arts of ancient Greece and Rome, and to their long precedent, more direct, derivation from the Semiticised primitive Turano - Hamitic arts of Central and Anterior Asia ; every tribe of Aryas that settled in Europe having had to traverse on its westward way the line of Egypto-Mesopotanean commerce that, from about the twentieth century B.C., extended continuously from Inner Africa to Central Asia. In some degree also it is due to the renewal of the Semiticised primitive Turano-Hamitic arts of Central and Anterior Asia, particularly in Trans-Alpine Europe, by the Aryan and Turanian barbarians who overthrew the Roman Empire ; and to the parallel renewal of them in Cis-Alpine Europe by the westward propagation of Christianity, and, later, of Mohamedanism, from Anterior Asia. And in a less, but still appreciable measure, it is due to the mediæval overland trade of Genoa and Venice with the East ; and again to the modern sea-borne trade established by Portugal, Holland, and England with India, the only country of the pan-Aryan pale of the Old World that has maintained the uninterrupted historical continuity, and the imprescriptible heirship of antiquity.

The Ancient History of Carpets.

In this brief review of the commercial and political conditions and vicissitudes of the two greatest industrial populations of antiquity, and of the evolutions along the course of their international relations of the economic, educational, and æsthetic arts, and religious culture of their intrinsically identical civilisations, we may trace in outline the history of the rise and progress of the immemorially famous Oriental manufacture of sumptuary carpets. Already, some time between B.C. 1000 and 800, they were known to Homer and the Homeridæ ; and if we bear in mind that the people of antiquity did not strictly discriminate, as we, since the seventeenth century only, have learned to do, between carpets and other tapestries, such as table-cloth, counterpanes, and coverlets generally, and curtains, and hangings of every description, it at once becomes clear that already at the time of the composition of the Iliad and Odyssey these textiles had acquired the ritualistic Euphratean types by which they have ever since been predominently characterised throughout Central, and Southern, and Western Asia ; as also that in their passage, through Phœnicia and Phrygia, into Europe, and in the course of their adaptation to the purposes of the Greeks, and, subsequently of the Romans, these textiles were, for the most part, completely secularised ; although in some of their uses, as for the veils of temples, they retained, down to the conversion of Europe to Christianity, the plenary religious significance always borne by them at Memphis and Thebes, and at Babylon and Nineveh, the four chief centres of their primary production.*

* The decoration of textile fabrics was at first entirely ritualistic, and pre-historically it would seem to have originated in tattooing : from which the rich symbolical vestments worn by kings and priests have, over the greater part of the world, been obviously derived. The practice was once universal, and is still widespread; and where it yet survives, is invariably ritualistic, indicating the relation of those so "stigmatised" to their tribes, and tribal divinities. That is to say the typology of tattooing, as still practised, is invariably totemistic and mythological, its mythology, most frequently, being of cosmological significance. And this was always so. In Genesis iv. 15, it is said :—"And the Lord set a mark upon Cain lest any finding him should kill him." In Ezekiel ix. 4 and 6, in the vision foreshadowing the destruction of Jerusalem for idolatry, a mark is set on the forehead of the men who remained true to Javeh, that they might be spared when the idolaters were slain utterly, "old and young, both maids, and little children, and women," and without sparing or pity. In Galatians vi. 17, St. Paul says :—For I bear in my body the marks (*stigmata* - literally, "prickings with a needle" *i.e.* tatooing,)—of the Lord Jesus ; and in the Revelation of St. John the Divine, xiii. 16, xiv. 9, 11, &c , we have repeated references to the mark of the beast, and to the mark on those who overcome the beast. Here the word invariably used is *charagma*—" a mark engraven " or "imprinted." The Hebrew word used in Ezekiel is *tau*, which is the Egyptian sign of the male element in nature and of life Again, Herodotus ii., 113, in the Egyptian account of the flight of Helen with Paris, says. that on reaching Egypt their attendants went off to the temple on the banks of the Canopic mouth of the Nile, and there dedicated themselves to Hercules; in sign thereof "receiving certain marks on their person ;" and thus delivering themselves from the service of the guilty fugitives. The historian adds :— "The law still remained unchanged to my time." This ritualistic tattooing was early forbidden by the Jews, probably out of opposition to the Egyptians, as is seen in Leviticus xix. 28 :—"Ye shall not make cuttings in your flesh for the dead, nor print any marks on you ; I am Jevah :" and Ptolemy Philopator (B.C. 222–505), in his malignant hatred of the Jews, forced them to be tattooed with ivy leaves in honour of the God Dionysos, whose ivy leaf he himself bore tattooed on his forehead. Those who did not submit to the idolatrous brand, as the Jews deemed it, were outlawed. Herodian tells us how the ancient Britons were printed with representations of the heavenly bodies ; and among the savages seen by the early European navigators along the coasts of the Americas, and in the South Seas, the tattooing was always found to be of this ouranographic description. Now we know from the Orphic Hymns that the spotted leopard's skin, or the spotted deer's skin (compare the spotted deer's skin worn by the Hindu Siva), worn by the worshippers of Dionysos, symbolised the shining frame of the spangled heavens, and the golden girdle the stream of ocean, and the crimson robe inter-tissued with gold, the life giving light and heat of the glorious sun. Here, the passage from tattooing to dress is clearly indicated

From Egypt, and from Chaldæa (later Babylonia), and Assyria, the manufacture of them spread into Asia Minor (Khita), where, at a very early period, it attained to great perfection in Phrygia (probably at Hierapolis, Dindymum, Fessinus, &c.), and Lydia (at Sardes, and probably Mæonia); and into Phœnicia (at Sidon and Tyre), and across to the island of Cyprus, were the primitive Nilotic, as distinguished from the archaic Euphratean, type of these textiles was perpetuated later than elsewhere in the East. On the destruction of Nineveh and Babylon the manufacture, after flourishing for a while at Susa, was taken up with great activity at Alexandria; and also at Seleucia, Ctesiphon, and Al-Modayn; and from Alexandria was imported into Western India; and from Al-Modayn and Ctesiphon, and Seleucia, as earlier from Susa, if not still earlier from Babylon, into Southern India. Finally, the Saracens, and the Seljuk, and Osmanli Turks, and other Tartars, who followed the Saracens in the propagation of the Empire of Islam, established the manufacture at Kufa, as the modern representative of ancient Al-Modayn, Seleucia, and Babylon; at Aleppo, and Damascus; at Baghdad in supersession of Kufa; at Cairo, the modern representative of ancient Alexandria, Thebes, and Memphis; at Kairwan, the modern representative, as regards the ritualistic arts of Northern Africa, of ancient Carthage; at Cordova in Spain; at Ushak (Brousa), and Koula, the modern representatives of Sardes, Mæonia, and Dindymum, in Asia Minor; at Ardebil, Feraghan, Kermanshah, Shuster (the modern representative of ancient Susa), Shiraz, Murghab, Teheran, Mashad, Herat, Subzawar, Sennah, Yezd, Kashan, and Kirman in Persia;* at Samarkand, Bokhara, Khiva, and Yarkand in Central Asia; at Kabul in Afghanistan; at Quetta in Baluchistan; and at Jamu, Hyderabad (Sindh), Shikarpur, Khyrpur, Lahore, Fathipur, Agra, Allahabad, Benares, Mirzapur, Morshedabad, Gorakpur, Patna, Arcot, Ellore, Nellore, Masulipatam, Warangal, Bellary, Bangalore, Ahmedabad, and elsewhere, in India. And wherever throughout the modern Mohammedan world of the East they introduced them, they employed in the decoration of their sumptuary textile fabrics, and particularly of their carpets, the same ancient Euphratean types of embroided, or inwoven, genii, seraph-beasts, and "Trees of Life," and the same floral diapers, of "the knop and flower" pattern, with the same borderings of sea and cloud scrolls, river meanders, mural gradines and chevrons, as are sculptured on the Nineveh marbles, and enamelled on the tiles of Susa; these strictly emblematical devices, as ultimately drawn in faultless beauty by the Greeks, but, unfortunately, without due reference to their spiritual pre-figuration, having also, for over twenty centuries, furnished the inexhaustible types of conventional ornamentation to the architects, sculptors, painters, and artistic handicraftsmen of the entire ancient pagan, and modern Christian, West. Where the orthodox Suni, or non-Aryan, form of Islam prevailed, as in Arabia and Central Asia, the animal types were eliminated from Saracenic art; but where its schismatic Shia, or Aryan form was developed, they survived, as in Persia, and parts of India; as partially also in the Suni countries of Islam, which, before their conquest by the Arabs, had been brought under intimate and enduring Aryan (Hellenic) influences, namely Egypt, and, in a less degree, Northern Africa generally, and Syria. But even in Asia Minor the drawing of "the Tree of Life," in the local carpet manufacture, is still severely Euphratean in character; while the carpets of

and the ritualistic origin of, at least, sumptuary vestments. Similar evidence is afforded by the descriptions of textile fabrics given by classical writers quoted in the body of this monograph, which all go to prove the identity of ancient pattern designing in textiles, with that still being everywhere pursued in Anterior and Southern Asia. The Musulmans following the Jews, rejected tattooing, but the fellaheen in Egypt, and the ryots in Syria, and certain of the women in Persia also, still tattoo themselves. Many of the aboriginal tribes of India, and some of the Burmans also, follow the practice, which, at present, reaches its highest elaboration in the great Polynesian South Sea, extended between Posterior Asia and the Continents of America. And everywhere throughout those regions it is totemistic or mythological, and in India and in Java, and others of the South Sea Islands, it has transparently suggested the ritualistic vestments that have taken its place for the use of those locally exercising the sacerdotal or sovereign authority. Nowhere is it found used merely for its attractiveness. In fact, in Burma, women are frequently tattooed expressly to detract from their beauty. In the early ages of the Christian Church nuns were for this very reason similarly stigmatised. Branding is indeed a survival of ritualistic tattooing, as are also crests and coats-of-arms as regards the objects borne. The ritualistic character of the dress, including the head-dress, shoes, and jewelry, of the Pharaohs, and the Chaldæan, Assyria, and Babylonian kings, is obvious and undeniable. Painting the body probably very widely marked the passage from tattooing to the use of vestments; and the extreme sanctity attaching to tattooing is proved by the practice of its subsisting, at least as a poetic figure, among the Jews, long after it had been forbidden among them by law; by its continued prevalence in Mohamedan countries; and by such legends as that of the miraculous stigmatisation of St. Francis of Assisi, St. Catherine of Siena, and other saints of the rival Franciscans and Dominicans.

* The modern town of Sultanabad, in Irak Ajami, is now the chief centre of the carpet manufacture of North-Western Persia.

the Caucasus (Daghestan), Kurdistan, and Central Asia, including Yarkand, alike in the details of their conventional ornamentation and their brilliant and harmonious colouring, are, we may surmise, absolutely identical with those of ancient Assyria and Babylonia. After these, the wonderful carpets of Bangalore (Malabar) probably approach, in their bold scale of design, and archaic force of colouring, nearest to their Euphratean prototypes. The old blue and red chequered cotton carpets (*satranjis*) of the Mahrattas, and the gaily striped, or otherwise mat-patterned, cotton rugs (*daris*)* of Kattyawar, Gujarat, and Rajputana, have in their crude, primitive designs, and almost prismatic colours, black, orange, red, yellow, green, blue, and white, preserved their ancient Egyptian physiognomy, of the period of the Ptolemies, without the slightest change, to the present day; while the Indian *susni*,* or counterpane, embroidered with white water lilies, has preserved in its name the record of its original importation from Susa, *i.e.*, the "City of Lilies." There need be the less difficulty, therefore, in coming to the conclusion that the grand, and, in India, quite exceptional type of the magnificent carpets of Bangalore, is to be traced back, through a direct descent of over two thousand years, to the spacious palaces of Susa and Babylon.

In Persia the Euphratean type of the local manufacture of curtains, coverlets, and carpets survived the alien Arabs and the Samani, Sabuktagini, and Seljuki Turks, and the Timuri Mongols; and it was not until the reign of Shah Abbas the Great, A.D. 1587-1629, the fourth sovereign of the native Shia dynasty of the Sufawis ("Sophis"), that a change was effected in the designs of these sumptuary tapestries, under the direction of the young Persians who, according to the tradition, as Sir Caspar Purdon Clarke, C.I.E., informs me, of the modern Persians, had been sent by the Shia Shah to learn painting in Italy "under Raffael" (A.D. 1483-1520), and certainly under masters of the school of Raphael. The Italianesque style thus introduced in the treatment of modern Persian carpets, and, with marked local modifications, of the Masulipatam (Coromandel), and other denominations of Indian carpets, if a departure from the traditionary Euphratean mode, is yet undeniably pleasing; and on account of its broken patterning, and generally diffused colouring, is better adapted to carpets intended for European rooms, where they are crowded over and overshadowed by other furniture, than the severely co-ordinated designs, and immense masses of clearly-defined deep-toned colours of the carpets of Ushak, Koula, and Bangalore,—that are only seen to their fullest advantage when spread under the domes of the mosques, or in the outer courts of the temples, or along the audience-chambers of the palaces, for which they are, in the first instance, manufactured.

The late Sir Bartle Frere had one of these Abbasi Persian carpets, brought for him by Sir Frederic Goldsmid, direct from Kirman. It is referred to by Sir Henry Yule in a note on the Chapter (17), "concerning the Kingdom of Kirman," in Book I. of his edition of the Travels of Ser Marco Polo; and I knew it well. The field was of a creamy white, overspread with pink and yellow roses, and the border black and green, scrolled with white roses and red. Another Persian carpet of this Italianesqued style was seen at the Vienna Exhibition of 1873; the field of margold yellow, all over diapered with pinks, and the border of dark turquoise blue, conventionally scrolled in yellow and true full pink. Both carpets reflected the light from their enchanted surfaces with the transparent radiance of the purest gems, harmonised to the neutral bloom of a richly-variegated garden seen in the soft sunshine of the dawning day, so skilfully were their rare colours blended.

The patronage by Abbas the Great of these Italianised carpets, as fresh and fair, and fragrant as one of his own enclosed paradises, was no matter of caprice or accident, but part of the general reaction of the Persians in the sixteenth century, A.D., against the degrading tyranny of their Turanian oppressors; and due, as its pre-disposing cause, to the instinctive love of the Iranian Aryas, as of every Aryan race, for the beauties of nature, and more especially for the swelling blossoms of the spring, the Raphael of the northern earth, as Jean Paul Richter has, in one word, so exquisitely described it:—"der Raphael der Norderde." The Parsis of forty-five and forty years ago used to frequent the Victoria Gardens, in Bombay, simply to "eat the air," that is, to take a good healthy walk there; and the Hindus to sniff at the most heavily scented blooms, which they would crush between their fingers, and apply, like snuff, to their noses. But when a pure Iranian sauntered through, in flowing robe of blue, red-edged, and his high hat of sheepskin, "black, glossy,

* For the etymology of these words, see footnote on the word Susan-gird, infra.

curled, the fleece of Karakul," he would stand awhile and meditate over every flower in his path and always as in vision; and when at last the vision was fulfilled, and the ideal flower found, he would spread his mat, or carpet, before it, and sit before it to the going down of the sun, when he would arise and pray before it, and then refold his mat, or carpet, and go home: and the next night, and night after night, until that bright, particular flower faded away, he would return to it, bringing his friends with him in ever-increasing numbers, and sit and sing, and play the guitar or lute before it,—and anon they all would arise together and pray before it; and after prayers, still sit on, sipping sherbet, and talking the most hilarious and shocking scandal, late into the moonlight: and so again and again, evening after evening, until the beauteous flower died, satiated of worship. Some evenings, by way of a grand finale, the whole company would suddenly rise up, as one man, before the bright, consummate flower, and serenade it with an ode from Hafiz, and, rolling up their carpets, depart into the silences of the outer night.*

Notwithstanding, however, the natural charm of the Abbasi Persian carpets of modern trade, the palm for pre-eminent artistic merit, above all other denominations of Oriental carpets now manufactured for merely commercial gain, must be awarded to those of Masulipatam and Bangalore; to the former, for their perfect adaptability to European domestic uses; and to the latter, on account of the marvellously-balaneed arrangement of their colossal proportions, and the Titanic power of their colouring, which in these carpets satisfy the feeling for breadth, and space, and impressiveness in State furniture, as if they were indeed made for the palaces of kings, and the temples of the gods; and these Southern-Indian carpets, the Masulipatam, derived from the Abbasi Persian, and the Bangalore, without a trace of Saracenic or any other modern influence, are both, relatively to their special applications, the most nobly designed of any denominations of carpets now made, while the Bangalore carpets are unapproachable by the commercial carpets of any time and place.

The Modern History of Carpets.

The restriction in Europe, since the commencement of the nineteenth century, of the use of Oriental carpets to covering floors, and of the meaning of the word carpet to floor coverings, has added to the difficulty sometimes felt in realising the indissoluble unity, in all their local diversities, of modern and ancient

* The attitude of the orthodox [*Suni*], or non-Aryan Muslim towards flowers, is different to that of the heterodox [*Shia*], or Aryan Muslim of Persia; and finds its exact expression in the profound saying, attributed to "the Prophet of God":—"The flowers of the Garden of God, this Earth of ours, are every one an 'Alleluia!'" When, some years ago, The Khedive was here, two of His Highness's suite, walking across St. James's Park from Storey's Gate, as I happened to be walking down from the Duke of York's Column to the India Office, coming upon a recessed group of various roses within the park railing, just before it turns westward to Buckingham Palace, struck by the transcendent beauty of the freshly blooming bushes, at once halted, and after giving them a spontaneous military salute, went through the postures—excepting that of absolute prostration upon the roadway—observed by Muslimun in the adoration of Almighty God. Mentioning this to the late Sir Charles Malcolm Kennedy, he told me that when, some years previously, he, on behalf of the Foreign Office, took an Envoy from Morocco about London, he seemed indifferent to everything shown him, that is, of the works of man; but when on entering the road skirting Flamsteed Hill—[Greenwich Observatory]—they suddenly came upon a handsome laburnum tree laden with its festoons of golden flowers, the Envoy at once stopped the carriage, and stepping down into the road, stood there for a while before the glorious apparition, similarly adoring God. Again the attitude of the Hindus towards flowers is something different from that of both sects of Muslimun. There is not a flower they have not dedicated to one or other of their gods,—and always on the basis of its phallic suggestions, which they were quick to observe milleniums before Erasmus Darwin sung of "The Loves of the Plants"; and their folk-lore of flowers is as delightful as it is luxuriant. But this apart, they seem to regard the wonders of the vegetable kingdom chiefly for their use as foodstuffs, and medicines, and scents. Nevertheless the floral ritual of the Hindus is often in its naturalness of sentiment and simplicity of observance, most impressive. The sacred *tulsi*, *Ocymum sanctum*, a most perfect purifier of the air, is planted before every Hindu house, on a four horned altar, and every morning "the Mother of the House" is,—or was, in my time,—to be seen perambulating it in archaic worship, invoking the blessings of Heaven on "the Father of her Children," and on them, and herself. I was always spellbound by the rite, so perfect alike in its science, its piety, and its art; and it is one of the most moving scenes from the life of Antiquity that have been perpetuated in India down to our Modernity.

It is only with the decay of virility in the West that men begin to regret in the beauty and the glory of flowers, that they fade and wither away. This irrational taint begins with Horace (C: II., 11 and contrast Anacreon, LIII.):—

> "Non semper idem floribus est honos
> Vernis:"

and from him the sigh passes to Ausonius [Edyll xiv.]:—

> "Collige virgo rosas, dum flos novus, et nova pubes
> Et memor esto sevum properare tuum:"

and to Ronsard:—

> "*Cuillez des aujourd'huy les roses de ta vie*":

and on to Herrick:—

> "Gather ye rose buds while ye may":

and

> "Fair daffadells we weep to see
> You haste away so soon."

This feeling is incomprehensible to a Muslim, who, in the inner court of the soul, sees in the phenomena of the outer court of the senses, the eternal witnesses of the infinite power, and wisdom, and goodness of a divine Creator, dwelling in the secret place of his habitation within the close drawn curtains of "the Holy of Holies."

Oriental carpets, and other sumptuary tapestries. The processes of their manufacture, and the designs for their decoration, have always been the same; and throughout the East they have always been indifferently used, or with vague differentiation, and denomination, as curtains, hangings, coverings of all sorts, and ordinary carpets. In Northern and Western Europe they were at first almost exclusively used as table-cloths, counterpanes, and wall hangings; and they only came into common use as floor coverings during the Protestant Reformation in Germany, Denmark, Sweden, Holland, and Great Britain, and that owing to the spoliation of the Catholic Roman Churches, and the scattering of their treasures, the accumulation of a millenium, among the predacious laity of the so called reformed churches, particularly in Great Britain. In England, ordinary cloths, even Oriental tapestries, had been occasionally used from the thirteenth century, by the prelates of the Catholic Roman Church and the nobility, for floor coverings; but, down to the seventeenth century, rushes were in general use for the purpose :—

> "All herbs and flowers fragrante, fayre and swete
> Were strewed in halls, and layd under theyr fete;"

while down to the middle of the eighteenth century, the word carpet still meant any sort of covering, either embroidered or woven, spread on a table, sideboard, or couch, or hung from a door or window, or upon a wall, or laid down on a staircase, or along a passage or floor. Only in the current century, in England, were carpets entirely withdrawn from their aboriginal indiscriminate use, and used exclusively as floor coverings; and was the meaning of the word carpet, reduced to its present precise interpretation: "A thick, tapestry-woven covering for floors." In the "Comedy of Errors," IV., 1, Antipholus refers to Adrian's desk—

> "That's cover'd o'er with Turkish tapestry."

Shakespeare knew of the use of carpets as a covering for floors, for in "Richard II.," III. 3, Bolingbroke speaks of marching his troops

> "Upon the grassy carpet of this plain;"

that is, the plain before Flint Castle. But in "Pericles," IV., 1, where Mariana enters on the open space, near Tharsus, saying:—

> "I will rob Tellus of her weed,
> To strew thy green with flowers; the yellows, blues,
> The purple violets, the marigolds,
> Shall as a carpet hang upon thy grave,"

the great dramatist had in mind the practice of hanging carpets, as has ever been done in the East, on graves, rather than that of spreading them on the ground. In "Twelfth Night," III., 4, Sir Toby Belch's protestation, "He is knight . . . . on carpet consideration"—refers, like the idiomatic phrase, "on the carpet" (*sur le tapis*), to the use of carpets as table-covers; the meaning of the sentence quoted, being that Sir Andrew Ague-cheek was knighted on courtly considerations, before his Sovereign at the Council Table, and not for services rendered on the field of battle. And all through the sixteenth and seventeenth centuries, such phrases as "carpet peer," "carpet-knight," and "carpet-squire," indicate men frequenting the tapestried chambers of kings and nobles: "carpet-monger," always meaning a flatterer, and "carpet-trade," flattery.

From the evidence afforded by the paintings of the early Italian and German masters, we find that the Oriental carpets imported into Europe during the later centuries of the Middle Ages (A.D. 486-1499), and the earlier portion of the Renaissance (fifteenth and sixteenth centuries) were, principally of both the geometrical and the degraded animal types of Central Asia, and also of the severely conventional "Tree of Life" type of Asiatic Turkey; while we learn, from actually surviving examples, that during the later period of the Renaissance, Persian carpets also began to be imported, but of the degenerate types imposed on the manufacturers of the country, during the prolonged period of its subordination to Turan (A.D. 980-1499), the "Dark Ages" of Persia. These are the carpets now so extravagantly prized by wealthy but tasteless collectors; exquisitely finished, often richly intertured with gold, and nearly always gloriously coloured, but rendered offensive by the introduction of incongruous Chinese, and other Tartar emblems, as also by the overcrowding of the decorative diapers and scrolls, and the feeble, helpless drawing of the whole design. Fortunately there are but few extant examples of these barbarous tapestries, which have only an antiquarian interest, notwithstanding the fabulous sums paid for them by the ignorant, and ostentatious patrons of any fashionable craze. During the seventeenth century, the English East India Company began to import the modern Persian carpets, of the Italianesque, Abbasi type; and these have ever since held the European markets equally with the Turkey carpets of Ushak and Koula. The European trade in the modern Indian carpets of Coromandel and Malabar, was wholly the creation, subsequently to the Great Exhibition of 1851, of Mr. Vincent Robinson,

C.I.E., founder of the house of Vincent Robinson and Co., of Welbeck-street, London.

Like the ancient, the modern manufacture of sumptuary carpets in the West, originated in the imitation of the carpets of the East, and its development has always kept pace with the importations of the latter by the Saracens,* from Persia, Syria, and Egypt, into Sicily, Spain, and France; by the Venetians, from Central Asia, Persia, and Turkey, into Italy and Germany; and by the English East India Company, from Persia and India, into Western and Northern Europe.

The first weavers of tapestries known to modern Europe, were the Saracens, who, introducing their looms into Spain and Southern France, transmitted to these countries the textile traditions inherited by themselves from Nineveh and Babylon, and Memphis, Thebes, and Akhmim; and it was from France that the weaving of tapestries spread into all the countries of Western and Northern Europe.

Up to the twelfth century A.D., the decorative hangings and coverings used in the latter countries were mostly of broidered, and very rarely of in-woven work; but after that date, owing chiefly to the example of the Saracens settled in Southern Europe, and partly through the influence of the intercourse, during the Crusades, of the Flemings with the Saracens, the loom gradually superseded the needle in the preparation of tapestries in Spain, France (Paris, Tours), Flanders (Antwerp, Arras, Bethune, Brussels, Bruges, Lille, Oudenarde, Tournay, Turcoing, Valenciennes), England, Germany (Nuremberg), and Italy. In France, the weavers of the new stuffs were at first distinguished by the names of sarrazins and sarrazenois; and still the Spanish for the upright, rustic loom ("tela jugalis") is sarazinesca, and for a carpet, the Arabic word, "alhombra," the name of the (red) palace in which the people of the Iberian peninsula were first familiarised with the use of sumptuary tapestries as floor coverings. The Spanish epigrammatist Martial informs us (XIV., 150) of a parallel revolution in the ancient manufacture of textiles, due to the shifting, by Alexander the Great, of the commercial centre of the Old World, from the valley of the Tigris and Euphrates, back again to the valley of the Nile; when, gradually, the work of the Babylonian needle was surpassed by that of the Memphian loom-comb ("pecten"):

> "Hæc tibi Memphitis tellus dat munera; victa est
> Pectine Niliaco jam Babylonis acus."

The new European manufacture was carried on intermittently, and more or less obscurely, all through the fourteenth, fifteenth, and sixteenth centuries; when in the seventeenth century, it received an immense and enduring impetus through the opening up of the trade of the English East India Company with the Persian Gulf.

The French, who had initiated the industry in modern Europe, again took the lead in its revival; and they maintained it till 1851. The English were, indeed, the first to send a dyer, Morgan Hubblethorne, in 1579, to Persia, to learn the art of dyeing and carpet weaving; but the French were the first to regularly organise the manufacture, and that with the aid, as it strangely happened, of weavers trained in the Persian processes, and style of decoration, in England. Thus the old factories, founded at Fontainebleau (1516) by Francis I. (1515-47), and at the Hôpital de la Triniti, Rue St. Denis, by Henry II. (1547-59), and at Tours, by Charles IX. (1560-74), were rapidly followed by the factories founded in the Faubourg St. Antoine (1597), transferred to the Louvre and the Tuileries (1603), and at the Palace of Les Tournelles, transferred to the Faubourg St. Marceau (1607) by Henry IV. (A.D. 1589-1610), and at La Savonnerie (1627), transferred to the Gobelins by Louis XIII. (1610-43); whose son, Louis XIV. (1643-1715), permanently established the manufacture, successively at the Gobelins (1662), at Beauvais (1664), and at Aubusson (1665). Beauvais has to the present day scrupulously observed the traditions of the decorative arts of ancient Egypt and Mesopotamia, thus received through Persia; subordinating the treatment of the conventional, or semi-conventional design, to the naturally flat surface of a carpet, and qualifying and distributing the colours, so as to secure that general diffusion of light and shade, and charming effect of neutral resplendence instinctively required in a fabric, intended, at least in modern Europe, to serve in its administration to household beauty, as a harmonising background to the furniture placed upon it; but at the Gobelins and Aubusson,

---

* Sarcenet is said to derive its denomination from the Saracens (Du Cange, "pannus Saracenici," Skinner, "sericum Saracenicum"); but I cannot help suspecting that the word may be rooted rather, or at least partly, in "sarcinator" and "sarcinatrix," the "patchers" of clothes, who in the lewd and luxurious days that prepared the fall of imperial Rome, were employed in adding silken linings, edgings, and other trimmings, to the traditionary classical garments of the simpler wardrobes of regal and republican Rome. There may also be in the word, an echo of the word "sarcinæ," the heavy bales in which goods of this sort were received from the East, through the mediation of the Arabs.

these immutable principles of ornamentation were from the first derided, discarded, and defied; the floral diapers and scrolls of the Italianesque Abbasi carpets, being replaced by vast scenic compositions of landscape, architecture, and moving idyllic, heroic, and mythological life, drawn in the strictest perspective, with borderings of heaped fruits and flowers in full relief; all pictured, as in a true painting, in immense masses of strongly contrasted colour, and light and shade; the result being that these tapestries of Aubusson and the Gobelins, together with the similarly false and vulgar porcelain of St. Cloud (1688), and subsequently, of Sèvres (1756) have, through the high vogue enjoyed by them exercised a most degrading influence on all the ornamental arts of Europe; from which the fictile, textile, and paper hangings industries of the United Kingdom of Great Britain and Ireland, have only begun to slowly recover since the Great Exhibition of 1851.

The manufacture of the new tapestries in England was first systematically undertaken by James I., at Mortlake, in Surrey, under the superintendence of Sir Francis Crane; and noble examples of his work are to be found on the Continent, as well as in the various Royal Palaces of this country, where his celebrated reproduction of the cartoons of Raphael are still preserved at Hampton Court. But the Civil War, so destructive to native art over all England and Scotland, wrecked the factory at Mortlake; and although restored by Charles II. it did recover itself, and on the death of Sir Francis Crane, it was closed, never to be re-opened. Thus the definite establishment of the modern manufacture of tapestries and carpets in Great Britain, has to be dated from the Edict of Nantes, in 1685, when a number of French Protestant dyers and weavers found an asylum here and naturalised themselves, with their beautiful art, in various parts of the country. In 1757, the Society of Arts awarded a premium to Mr. Moore for the imitations of Turkey carpets, produced at his factory in Paddington, under the direction of Mr. Parisot, a descendant of one of these French refugees. This particular manufacture was afterwards established at Axminster, in Devonshire; at Wilton, in Wiltshire; at Holyrood, near Edinburgh; and afterwards at Glasgow and Kilmarnock in the West of Scotland; and these English and Scotch denominations of pile carpets are the finest now made, beyond Turkey, and Persia, and India. All, indeed, now wanted to perfect them is to adapt the forms and colours of British flowers, and leaves, and trees, and of British national emblems, to the diapers, scrolls, and "Tree of Life" pattern, and the medallions, all in the Persian style, with which they are ornamented. It is absurd introducing the tropical palm, and pomegranate, and sacred lotus, into the decorative arts of temperate Europe, where we possess, in our own woods, the pine, oak, and mountain-ash, and in our fields the daisy, buttercup, bluebell, fritillary, violet, eglantine, honeysuckle, columbine, golden chrysanthemum, camomile, poppy, and cornflower; and for national floral emblems, the rose, shamrock, thistle and leek.

About the end of last century, the Brussels denomination of carpet manufacture was introduced into Wilton, from Tournai, in Belgium; and now flourishes at Kidderminster, in Worcestershire.

Every denomination of modern European carpets has thus been traced back to the ancient carpets of Central Asia, Persia, Western Asia, Egypt, and India; and their affiliation would never have been lost sight of but for the repeated breaches made in the historical evolution of the industrial arts of the Old World: by the overthrow of the Western Roman Empire by the Goths and Huns, and Vandal, and of the Eastern Roman Empire, and the Sassanian Persian Empire, by the Arabs, the Turks, and Mongols; and by the violence with which the Protestant Reformation was carried out in Germany, and Holland, and Great Britain; and again, so far as the last-named country is concerned, by the Civil War.

If this has been made clear, there should no longer be any serious difficulty in recognising the presumptive, if not the absolute identity of the modern denominations of tapestry and pile carpets with the sumptuary tapestries of antiquity as made known to us by the monuments of Egypt and Mesopotamia, and the literatures of Greece and Rome.

Tapestries, &c., in the Monuments of Antiquity.

Among the ruins of the great necropolis at Medinet Abu (Thebes) of the Pharoahs of the New, or Second Theban Empire (B.C. 1700-1000) one of the frescoes represents the weaving, by three men, of a patternless web, on an upright loom furnished with a regular cloth beam ("insubulum," "tela insubulis"). At Beni Assan (Speos Artemidos) the beautiful grotto-like tombs, with proto-Doric columns of the Pharoahs of the Middle, or First Theban

Empire (B.C. 3100-1700), one of the wall paintings represents a party of Egyptian women, apparently superintended by a man, filling the distaff ("colus") with cotton or lint, twisting it with a spindle ("fusus") into thread, dyeing the thread, and weaving it on a simple, that is cloth-beamless upright loom ("tela jugalis"); separating, that is decussating, the threads of the warp, ("tela," "stamen") with a leash rod ("liciatorium," "arundo") to form the tram-way ("trama" cf: "trames," "a cross-path") through which the threads of the woof ("subtegmen," "subte-men," "subteximen") are being passed, and beaten home, not with the true shuttle ("alveolus") and batten ("spatha," "arundo"), or the comb ("pecten"), but with the "radius," a very ancient textrine instrument, similar to the long weaving reed of the Hindus, and serving at once as shuttle and sley. In both of these looms the web is fastened down to a yarn-beam ("scapus,") instead of being kept taut by weights, usually stones ("pondera")* as is still done in India. Another of the Beni Hassan pictures represents a man weaving a small chequered carpet on a horizontal loom.

On the storied walls at Thebes are also to be seen representations of ships with sails, woven over the field in large chequers of green and red, and along the borders, in red, yellow, and blue chevrons; of regal thrones, covered with red and blue stuffs, diapered with roundels and rosettes; of the awning of a royal pavilion, bordered with rows of the sacred basilisk (the Uraeus cobra, *hadji*), alternating with rows of roundels, gradines, and "the knop and flower" pattern; and of the corslet of Ramses III. (B.C. ?1200-1166 ?1269-1244) figured, within its four compartments formed by perpendicular bands of chevrons, and horizontal bands of "the knop and flower" pattern, with lions and camels; the latter a beast, said not to have been known, in the flesh, to the Egyptians, until after the Roman occupation of their country. Herodotus (B.C. 484 — circa 424) mentions (ii. 182) that Aahmes II. (B.C. 570-526) presented a corslet of linen to the temple of Pallas at Lindus, and (iii. 47) another to the Lacedemonians. The latter, he says, "had figures of animals inwoven with its fabric, and was likewise embroided with gold and tree wool (cotton); and he adds:—"The corslet which Amasis (Aahmes II.) gave to the temple of Minerva in Lindus was like unto it." Each thread of these corslets consisted of 360 threads, and the Roman Consul Mucianus, told Pliny, the Naturalist (xix., 7, A.D. 23-79), that when in Rhodes he saw the corslet at Lindus, but very little then remained of it, in consequence of the injury it had suffered from the fingers of visitors anxious to verify the fact of the extraordinary complicity of its finely-twisted threads. At Sakkara the sleeve of an Egyptian dress has recently been found similarly ornamented with embroidery on the woven web; a characteristic Egyptian fashion of work referred to also by Lucan (A.D. 65) in his description (x. 141-3) of the robe worn by Cleopatra when she feasted Julius Cæsar in Alexandria: "Her white breast shone through the Sidonian tissue, which finely wrought with the sley of Seres, the needle of the Nile (in embroidering it), separates, loosening the warp of the extended web."

> "Candida Sidonio perlucent pectora filo,
> Quod Nilotis acus percussum pectine Serum,
> Solvit, et extenso laxavit stamina velo."

Sir J. Gardiner Wilkinson mentions (Ancient Egyptians, vol. iii., 172) an ancient Egyptian carpet discovered by Mr. Hay at Thebes. It has in the centre of the field the figure of a boy in white, on a green ground, surmounted by a white goose, the Egyptian hieroglyph of a boy; beyond this lozenge, the ground is yellow, variously figured in white; the whole being bound in by a border of lines of red, white and blue, and a triangular device, running all round the extreme edge of the carpet. Evidently it belongs to the same period (A.D. 284-640) as the carpets, and other fabrics, discovered by Maspero at Akhmim, when the native Pharaonic art of ancient Egypt had become modified by the debased Greek art of the Lower Roman (Byzantine) Empire.

There are no actual remains of ancient Assyrian and Babylonian carpets, but the slab with large rosettes sculptured in the centre, and "the knop and flower" pattern along the border, discovered by Layard, in the doorway of the palace of Sennacherrib (B.C. 705-681), on the Koyundjik mound near Mosul (Nineveh); and the door sill, with a similar border, and a centre of a cross-barred, semi-floreated, semi-geometrical diaper, found in the palace of Sargon (B.C. 722-705), on the Khorsabad mound, north of Mosul; together with the enamelled bricks found at Khorsabad, and in

* In Western India I have seen the horizontal loom kept stretched by swathing the web, as worked, round the weaver's body. And I have seen thread spun from cotton wool by the simple expedient of using the left hand as the distaff, and the right as the spindle and reel.

the palaces of Esarhaddon (B.C. 681-668) and Assurbanipal (B.C. 688-626) at Nimrud (Calah); and the decorations of the royal robes of the Chaldean King Merodach Nadin-Akhi (B.C. 1100), and of the Assyrian kings represented on the "Nineveh marbles": all these contemporary documents incontestibly prove that, in design, and colour, the carpets woven in Hindustan and Central Asia to-day, are the self-same carpets as were used for awnings, and floor covering, in the palaces of Sargon, Sennacherrib, Esarhaddon, and Sardanapalus, "the great and noble Asnaper" of the Book of Ezra (iv., 10). The stone slab from Koyundjik, and the door sill from Khorsabad, are palpably copied from carpets, the first of the style of the carpets of Bangalore, and they were probably coloured like carpets; while the pectoral worn by Sardanapalus, as it is seen on the "Nineveh marbles," is an exact miniature of a Kurdish carpet with the "Tree of Life" in its field, and its border set with alternate bars and rosettes (lotus flowers); while the same difficulty has been felt by the designer in turning the corners of the carpet with the rosettes and bars as may be still observed in Kurdish and other Eastern carpets. In short, the carpets now woven in Asia Minor, Persia, and Turkestan, and in Southern India, faithfully repeat, alike the general scheme of design, the decorative details, and the colouring of the Assyrian and Babylonian sumptuary textile of fabrics of B.C. 1000-606 (Fall of Nineveh) and 538 (Fall of Babylon).

The monuments of the Hittites in Syria and Asia Minor prove that the arts of this semi-Semiticised Tartar people were borrowed direct from those of the Egyptians, and the Chaldean and Assyrians; while the elaborate costume of the Hittite king, or priest, sculptured, worshipping before some Earth God, on the side of a spur of the Bulgar Dagh, at Ibriz, is ornamented with the same patterns as those found on the oldest representations of textile fabrics in Chaldæa and Assyria, and Egypt, and to this day, in Kattyawar Gujarat, Sindh, and Rajputana in India. The broad hem of this regal, or sacerdotal, robe, bears the *swastika* pattern, the predominance of which now, everywhere, marks the Turanian art of the Old World, as that of the "Tree of Life," and the "knop and flower" distinguish the Aryan.

In Anatolia the façades of the Phrygian tombs are decorated with the same patterns as are at present used on the carpets woven by the Turcoman nomads of Asia Minor and Central Asia. These tombs are in short reproductions of the wooden houses of the ancient inhabitants of Asia Minor, and the façades, of the carpets they hung before them; and still in the East carpets are not only hung before the entrances of tents and other dwellings, but over the graves of the dead.

There are neither any remains, nor representations of the textile fabrics of either the Phœnicians or the Jews. But we know from Hebrew, Greek, and Latin literature, that these Semitic peoples were famous, from the earliest times, for their love of the sumptuary arts; and that the tissues of Sidon and Tyre were always highly prized, although more perhaps for their purple dyes than their designs. Carthage, a colony of Tyre, also acquired a high reputation for its figure stuffs.

In Persia, the Egypto-Assyrian sculptures of Persepolis, and the brilliantly enammelled tiles of Susa, but repeat the story of the intimate affiliation of all the industrial arts of the ancient Old World. The warriors painted on the glazed tiles at Susa wear robes of the patterning of the robe worn by the king, or priest, on the Hittite sculpture at Ibriz; and an encaustic flooring, with its chequered field, and border of the "knop and flower" pattern, cannot be discriminated in design, from the large Mahratta *satranjis* used, during the early decades of the present century, in the palaces of the Peshwas at Poona, in Western India. Persia received all her arts from Egypt, from Assyria and Babylonia, and from Lydia and Greece; but through her predominant position in Anterior Asia, she powerfully reacted on these countries all through the Achæmenian (B.C. 559 331), Parthian (B.C. 226—A.D. 226) and Sassanian A.D. 226-651) periods; and thus became one of the principal agencies in the evolution of the Byzantine art (sixth to twelfth centuries A.D.) of the Lower Roman Empire, and of the Saracenic art (seventh century to A.D.-x) of Islam.

As would be anticipated from their natural good taste, and love of symmetry and proportion in all things, there are no detailed illustrations of sumptuary textile fabrics among the remains of the plastic and glyptic arts of the Greeks; while the delineation of them is less definite than might have been expected even in their fictile art, fraught as this is with the reality of their daily lives. There is a solitary engraved gem, now in the Berlin Antiquarian Museum, and figured in King's "Antique Gems and Rings," xix. 8, representing Athene in the act of transforming Arachne into a spider, the loom here being a domestic form of the simple "tela jugalis." The "tela in-

subulis" in its crudest and most rustic form, is represented on a vase of the fifth century B.C., found in 1888, on the site of the Kabeiriron at Thebes, and now in the British Museum; and on the vase of the same date, purchased for the Oxford Museum, from the Van Branteghem Collection; both being illustrated in the "Journal of Hellenic Studies" (vol. xiii., part I., 1892-3. On an Attic vase of the fifth century B.C., a Greek lady is represented spinning thread; and on another of the same date, threading a shuttle; while on the Attic vase, of the same date, found at Chiusi, and now in the Berlin Antiquarian Museum, is the famous representation of Penelope sitting beside her loom, with Telemachus standing before her. The loom is a complicated expansion of the "tela insubulis;" the web on it showing a richly inwoven pattern of winged beasts and winged men, of the Egypto-Mesopotamian type, with here a star, and there a *swastika*, set before them; and a border of the familiar Egyptian frets and stripes.*

An Attic vase of the fifth century B.C., now in the Campanari Collection, represents two Greek women folding up clothes, either after having woven or washed them. The large Attic vase, found at Cervetri, and now in the Vienna Museum, is painted with the scene of Priam's visit to the tent of Achilles, the sumptuary coverings of the couch on which Achilles reclines, and the bales of carpets offered to him by Priam, being all of the Egyptian patterns of the monuments at Medinet Abu, Luxor, and Karnak. These are the only classical illustrations known to me of coverlets and carpets; other representations of the textile manufactures of the Greeks and Romans being all of more or less elaborately ornamented articles of male and female attire. But the painting of Chryses propitiating Apollo, on an Italic vase in the Jatta Collection at Rome; of Thamyris and the Muses, on the Attic wine jar in the same Collection; of the heroes in Hades, on an Italic vase, now in the old Pinakothek, Munich; and of warriors arming and mustering for battle on an Attic drinking cup of the fifth century B.C., in the Museum of Art and Industry at Vienna; of the wedding of Peleus and Thetis, by Clytias and Ergotimus, on the celebrated François vase; of the Judgment of Paris, on the Attic vase, figured in the Romische Mittheilungen, vol. ii., of 1887; of the Assembly of the Gods, by Oltos and Euxitheos, on an Attic vase of the fifth century, now in the Corneto Museum; of Alcmene and Megara, by Assteas, on an Italic vase of the fourth century B.C., now in Madrid; and of Leda and the Dioscuri, by Exekias, on an Attic vase of the sixth century B.C., now in the Museo Gregoriano at Rome; all these fictile paintings prove that the costumes worn by the Greeks and Italiots, and Thracians, and Lydians of the sixth to the third centuries B.C., were not only similar in their general character, but absolutely identical in their patternings, with the gay and costly costumes represented on the monuments of the Egyptians, Chaldæans, Hittites, Assyrians, Babylonians, and Persians from the earliest to the latest dates of their history; and also with those of India, and the greater part of Anterior Asia and Northern Africa to the present day.

In Italy, there is at Pompeii a fresco of the imperial Roman period, representing an awning, with alternated dolphins and sea horses careering along the limits of the field, and a tesselated pattern on the heavily-fringed border.

The Christian period of the stromaturgic arts is beyond the scope of this retrospect of their history, as recorded on the monuments of antiquity; but in turning from the latter I must mention the mosaic at Ravenna, in the church of Sant' Apollinare (nell à Citta) built in the sixth century by Theodoric the Great (A.D. 493-556), representing the palace of the Ostrogothic king; because its corridors are hung with curtains in the very same fashion as was followed during the picturesque times of Peishwas in draping the colonnades, forming the aisles, of the old Mahratta palace at Poona*, and, as happens, the curtains of

* This vase painting is reproduced by Professor J. H. Middleton in his article on Textiles in the last Edition of the "Encyclopædia Britannica."

* The destruction of this palace by fire in 1827 will never cease to be regretted by the student of the history of art in India, for like the still standing temple of Vishnu, in his avatar of Rama, on the island of Ramisseram, it was a striking example of the survival of the sumptuous building style of Mesopotamia in India down to the most modern dates immediately preceding the English conquest of the country. It was commenced by Baji Rao I., the second Peishwa (A.D. 1720-1740), and completed by his successor Balaji Baji Rao (A.D. 1740-1761); and was built in the Shanvar ward, because Baji Rao I. happened one day to see a hare drive a dog off the spot, thought that a palace built there would never be taken by the Mo(n)gols of Delhi. It was seven stories high, the seventh story being the Asmani Mahal, or Palace of the Firmament, erected by Baji Rao II. the last Peishwa (A.D. 1795-1853), whose adopted son was the infamous Nana Sahib. It was divided into four larger and three smaller courts, and contained seven Divan Khanas or reception halls. The latter each consisted of a long hall with lateral corridors, separated from the body of the hall by richly carved pillars. The ceilings were covered with beautiful carving in wood, and the walls were all painted

Theodoric at Ravenna, and of Baji Rao at Poona, were covered with a similar floral diaper.

Tapestries in the Bible, and the Literature of the Greeks.

It would be impossible to quote, within the space as my disposal, all the literary allusions and references of the ancients to tapestries, and under this head I must confine myself to a summary review of the more remarkable passages, relating to these fabrics, to be found in the Hebrew, Greek, and Latin writers.

Beginning with the Bible, we find in the Pentateuch, chapters xxvi-viii, xxxv-vi, and xxxviii-xl of the Book of Exodus, devoted to a minute working specification of the ritualistic furniture of the Tabernacle or Tent of Javeh, and of the vestments of the ministering Cohen and Levites. In chapter xxvi., verse 1, we are told that the ten lateral curtains of the Tabernacle were "of fine twined linen, and blue, and purple, and scarlet, with cherubims of cunning work"; in verse 31, that the veil of the Holy of Holies was "of blue and purple, and scarlet, and fine twined linen of cunning work, with cherubims embroidered thereon"; in verse 36, that the outer veil, or hanging, at the entrance into the Tent, was "of blue, and purple, and scarlet, and fine twined linen, wrought with needlework"; and in chapter xxvii., verse 16, that the hanging "of the gate of the court" of the sacred Tent was coloured in the same manner, and similarly "wrought with needlework." In II. Kings, xxiii. 7, Josiah is recorded to have destroyed the houses that were by the House "(the temple of Solomon)" of the Lord, where the women wove hangings for the Grove (Asherah), *i.e.*, "the Tree of Life" symbol, worshipped by those, mentioned in verse 5, "that burned incense unto Baal, to the sun, and to the moon, and to all the host of heaven." In the Book of Esther (circa B.C. 450), chapter 1, verse 6, we read, according to the Authorised English Version, of "the white, green, and blue hangings" of the King's palace at Shushan (Susa, now Shuster). But the Hebrew word, *karpas* (here translated, "green"), is the Sanskrit word for cotton (*karpasa*, carbasus); and the passage really refers to the well-known blue-striped cotton carpets of India, called *daris*, *i.e.*, "door"-mats, and *satranjis*, literally—"four-colans." In Psalms civ., 1, 2, the prophet Ezra, or Nehemiah, apostrophises the Creator in the sublime words:—"Who coverest Thyself with light as with a garment: Who stretchest out the heavens like a curtain." In the Proverbs vii., 16, King Solomon, in his graphic apologue of the cunning woman, and the desperately simple young man, of the period, describes the former, as saying:—"I have decked my bed with coverings of tapestry, with carved works, with fine linen of Egypt;" or, as the Revised English Version has it: "I have spread my couch with carpets of tapestry, with striped cloths of the yarn of Egypt." And again, in chapter xxxi., verses 22 and 24, in his antithetical picture of the points and properties of a good wife, he says, amongst other things in her praise:—"She maketh for herself coverings (R.V., carpets) of tapestry; her clothing is silk (R.V., fine linen) and purple." She maketh fine linen (the R.V. adds—garments) and selleth them, and delivereth girdles unto the merchant (literally, the Canaanite, *i.e.*, the Phœnician)." In this passage the Hebrew word, rendered fine linen, is *sadin*, which is the Greek *sindōn*—that is "Indian"—muslin. In the Song of Solomon, the bride, in chapter i., verse 5, speaks of herself:—"I am black, but comely, O ye daughters of Jerusalem, as the tents of Kedar, as the curtains of Solomon;" while in chapter iii., verse 10, the chariot of Solomon is described as covered with purple; like the "serica carpenta" (Propertius IV., viii., 23) of the Romans; and the silver gilt, and silk-canopied and curtained, gay *eka* of the Hindus. Finally, in the Book of the Prophet Ezekiel (circa B.C. 596—74), in chapter xxvii., verse 20, it is said of the rich and universal trade of Tyre:—"Dedan was thy merchant in precious clothes (cloths) for chariots." Some have translated this as "magnificent carpets for chariots." It is indifferent which translation is the closer to the original Hebrew, for either equally indicate the sumptuary tapestries for which India, and Irak Arabi, have ever been renowned. In verses 23 and 24 of the same chapter, Haran and Canneh, and Eden and Sheba, Asshur and Chilmad, are enumerated as trading with Tyre "in all sorts of (excellent) things; in blue clothes, and broidered work, and in chests of rich apparel, bound with cords, and made of cedar." All the commentaries are agreed that the cotton

with scenes from the Itihasas and Puranas in enamelled colours and gold. It was from the sixth storey of this palace that Madu Rao Narayana, the fifth Peishwa (A.D. 1713-1795) threw himself on the fountain in the court below, sustaining such injuries from the fall that he died on the following day.

woollen, and silken stuffs of ancient India, in which the Arabians traded with the West, by way of the Persian Gulf, and Aden and the Red Sea, are here meant; and the "cedar boxes," were probably deodar cases, containing woollen stuffs, similar to the present Cashmere shawls; and the blue clothes, or "blue foldings," as the marginal version has it, were possibly the indigo-dyed vestments still made upon the loom, without seam, and still woven in one piece, all over India.

There is no stronger proof of the personality of Homer, and, I would add of a Semitic strain in his Mœonian blood, than his exceptional, and among Hellenic writers, quite extraordinary feeling for the beauty of sumptuary objects of every sort, and particularly textile fabrics; which he was the first, by the force of his sympathetic genius, to invest, and for all time, with the spiritual fascination of the highest poetry. He sings their praises in almost every book of the "Iliad" and "Odyssey"; and all I can do here is to indicate the passages in which he specifically refers to tapestries, under the denomination of *tápes*, and then to quote some of his descripitons of the manner in which textile fabrics generally were ornamented in his time. The textile denomination *regos*, a "rug," "carpet," or "covering," frequently occurs in the "Iliad" or "Odyssey," and generally with the qualification, "beautiful;" but it cannot be identified with any true variety of sumptuary tapestry, and was probably a fabric of loosely woven, or possibly felted wool, owing its beauty to its softness, and the bright colour in which it was often dyed.

In the "Iliad," ix., 200, the heralds of Agamemnon sit "upon couches and (*tápesé te porphuréoisin*) purple coverlets;" in x., 156, Diomed sleeps outside his tent, "but under his head a splendid tapestry (*tápes phœinós*) was spread;" in xvi., 224, among the contents of the chest presented to Achilles, by Thetis, are expressly mentioned, "pile carpets (*oulon te tapéton*;" and in xxiv., 230, among the presents taken by Priam to Achilles, for the ransom of the body of Hector, were "twelve carpets (*te tapetas*)."

In the Odyssey, iv., 124, Alcippe brings Helen "tapestry (*tápeta*) of soft wool," while in lines 297-8 of the same book, Helen spreads on the couches, on which Nestor and Telemachus are to sleep, "beautiful (purple) blankets (*régea*) with tapestry (*tápétas*) on the top of them" as a counterpane; in vii., 337, Aerte directs the bed of Ulysses to be made up in the same way, and in the very words used in Book IV., 298; and in X., 12, the sons of Aeolus are described as sleeping, "with their chaste wives, on tapestry," as the humbler classes of the natives of India still sleep in the verandah of their master's house, with their wives, on carpets, unrolled for the purpose every night, and rolled up again every morning, and laid aside during the day.

As to the textile designs of the Homeric period, in the Iliad, III., 125-27, Helen is found, by Isis, "weaving a great web of twilled purple, wrought with the many woes of both the horse-taming Trojans, and the bronze-armoured Greeks, that, on her account, they had suffered at the hands of Ares"; in VI., 289-94, Hecuba descending to her fragrant chamber, where "were her variously embroidered robes, the work of Sidonian women," takes one of these, "the most beautiful for its variegated embroidery, and the largest, and which glittered like a star," and hastens with it to the temple of Athene, to place it, as an act of propitiation, on the lap of the blue-eyed goddess; in XIV., 178-85, Here folds around her "an ambrosial robe, wrought by Athene in needle work, with much varied decoration, and girding herself" with a zone, adorned with a hundred fringes, throws over all "a beautiful veil, bright as the sun"; and in XXII., 440-41, Andromache, all unconscious of the death of Hector, is described as weaving a web of twilled purple, and embroidered with a diaper of flowers. In the Odyssey, xv., 417-18, there is a reference to a Phœnician woman "skilled in (weaving) resplendent tapestries," "in resplendent emroideries (*aglaà erga*);" while in Book XIX., lines 225-233, is the description of the cloak of Ulysses:—

"The god-like Ulysses had a cloak of twilled purple, with a clasp of gold, double buckled. It was embroided on the front, where a dog, panting with joy, held down, with its fore feet, a spotted fawn; and all wondered to see how, being but wrought in gold thread, the one gloated over his prey, and the other, eager to escape, struggled convulsively with his feet. The beautiful garment fitted to his body, like its slender skin to an onion—so soft was it, and it shone like the sun; and the women all feasted their eyes upon it."

Æschylus (B.C. 525-456) in "Prometheus vinctus," 24, speaks of "night in spangled robe"; in the Persians (836-821), of the tattered condition of the "embroidered robes" of Xerxes; in Agamemnon (909-864), of strewing

the path of the returning hero "with carpets"; (910-865) of "a purple-strewn path"; (923-878) of walking on "embroidered fineries"; (926-881) of "carpetings and embroideries"; and again, (957-912) of "treading on purple"; in the Choephori (229-30, 225-6), of the "woven robe" of Orestes, the work of Electra's hand, "the strokes of her batten, and the representations of wild beasts"; and (1011-1000), of the blood of Agamemnon staining "the many colours of his embroidered (robe)"; and finally in the "Suppliants" (277-83, 267-73), he makes Pelagus address the Chorus:—"It is incredible what you relate, O strangers, that you are Argives; you are more like Lybian women, and by no means resemble natives of my country. The Nile might have nourished you, and the Egyptian decoration (*Kúprios charactér*, "Cyprian *motifs*, *i.e.*, 'the knop and flower' pattern), on your chintzed raiment shows that it was woven by male weavers."*

Sophocles (B.C. 496-405) in "Œdipus Coloneus" (340-44, 337-41), seems also to share this belief of the Greeks, that the weaving in ancient Egypt, was all done by the men, making Œdipus remark of his sons:—"In the nature and breeding of their lives, they are in everything like to the people of Egypt, for there the men sit indoors working at the loom, while the women procure the means of support out of doors." Herodotus II., 35, says the same thing, but we now know, from the monuments, that there were female weavers in ancient Egypt, as well as male.

Euripides (B.C. 480-406), in "Hecuba," 466-74, refers to the representations in embroidery, on the saffron robe, or veil, carried at the Panathenaic festival, of "the steeds harnessed to the car of Pallas, and of the Titans whom Zeus sends to eternal rest with his flaming lightnings"; in "Iphigenia in Aulis," 73-4, to Paris, coming from Phrygia to Lacedemon, "in flowery garments, glittering with gold, barbarian fineries"; in "Iphigenia in Tauris," 222-224, once more to the robe, or veil, which was the great feature of the annual† Panathenaic festival, "adorned in the sweetly humming loom, with the image of Pallas Athene, and of the Titans"; and 814-16, to a deftly-wrought web: representing the Argonautic Expedition, and another, "the turning away of the sun"; in "The Troades," 991-2, to Paris, "radiant in barbarian vesture and gold"; in "Ion," 506, to "woven pictures"; and 1141-65, to the "sacred tapestries" of Delphi, wherewith Ion covered the banqueting tent pitched by him below the crags of Parnassus. I must give the description Euripides has left of them, in full:—

"First, he (Ion) spreads over the roof a double peplum (robe or veil), the gift of the son of Zeus, which Heracles brought to the God, the spoil of the Amazons. And these woven figures were painted on the texture: Ouranos collecting the stars in the circle of ether; Helios driving his horses down to the waning light of day, drawing with him the lambent light of Hesperos: and black-robed Night, driving her two-horsed chariot, the stars following the Goddess; the Pleiades travelling through the mid air, and sword-bearing Orion. Above was Arctos, turning round the Golden Pole. And the circle of the full Moon, the measurrer of the Months, darting its rays; and below, the Hyades, the most Henspeckle sign for sailors, and Eos, chasing away the stars. And upon the walls he placed other weavings of the barbarians, in their well-rowed ships, drawn up in array against the Greeks; and savage men, and huntings on horseback, and the chase after stags and fierce lions. And at the entrance into the tent was Cecrops, and near by, his daughter, rolling in her dragon folds, —the gift of some Athenian."

And again in the same tragedy of "Ion," 1417-25, Euripides refers to a web with a Gorgon in the centre, and fringed with serpents, like the ægis (literally "goat" skin) of Pallas Athene; which when shown to Creusa she salutes with the exclamation: "O ancient virgin-labour of my loom"; and in line 1491, describes as "the plying of my shuttle." In "Andromache," 148, he refers to Hermione's vesture of "embroidered robes," and in Electra, 314, and 1000-1001, to "Phrygian spoils," *i.e.*, embroideries; while in lines 454-78, he gives a description of the ornamentation of the shield, helmet, and cuirass of Achilles, recalling that given by him of the sacred tapestries of Delphi, in "Ion."

Aristophanes (circa B.C. 444-380, 450-385) has numerous references to spinning and weaving, particularly in Lysistrata, and also to the ordinary plain saffron* coloured clothing of the Greek women of his time, and a few to sumptuary articles of attire, such as the "Cimmerian robe," and the "Persica"†, or

* This is an exegetical—and paraphrastic—translation of a difficult passage, adopted by me in accommodation to, and emphasis of, my conviction that the said passage affords an indication of a contemporary knowledge of the connection between the artistic culture and general civilisation of Cyprus and Egypt that has been fully demonstrated by modern archæological research.

† Some say quadrennial.

* Saffron was the favourite colour of Greeks, purple of the Romans, red of the Gauls.

† Compare persica the peach, *i.e.*, Persian fruit.

Persian slipper, but his only references to tapestries of any kind, are in Lysistrata, 933-5, where Myrrhina tells Cinesias he has not a "counterpane," and he, as she runs off for one, mutters:—"The women kill me with bedclothes;" and in The Frogs, 542, where Bacchus speaks of a slave lying on Milesian bedclothes.

Theocritus (3rd cent. B C.), also, while full of the subject of spinning, has little to say of sumptuary tapestries. In Idyl XV., 80-7, Gorgo directs the attention of Praxinoe to some charming embroideries, on which the latter, exclaims:—"O Athene! what woman could have wrought, and what designer drawn them? How true to nature the figures stand, and move about, like living creatures, not woven patterns. And Adonis himself, how beautiful, reclining on his silver couch, in the first bloom of manhood; thrice beloved Adonis, Adonis beloved even in death!" And in the immediately following Psalm of Adonis occurs the famous lines:—"O, the purple coverlet more soft than sleep! [cf Virgil, *Eclogue* vii., 45]. So Miletus will say, and the shepherds of Samos."

Polybius (B.C. 204-122), in the account he gives (XXXI., 3, 10) of the great festivities held at Daphne, by Antiochus Epiphanes (B.C. 165), states that the "Companion Cavalry," and the cavalry corps of "the King's Friends," and the "Cavalry of the Guard," and the "Cataphract Cavalry" who took part in the celebration, to the number of 4,500, all wore "purple overcoats," in many cases embroidered "with gold, and figures of animals." This statement, it will be seen below, is repeated by Athenæus.

Diodorus Siculus (circa B.C. 90—A.D. 14) is more barren than Herodotus of notices of sumptuary tissues; but his description, B. II., of the scenes depicted on the glazed tiling of the circular wall of the royal palace at Babylon is worth quoting in this place, as indicating one of the sources in which the scenic tapestries of the East originated:—"On the wall, and on its towers, were represented every kind of living creatures, painted in the most brilliant colours; especially huntings of all sorts of wild beasts, each scene four cubits high, and upwards. Among them, was one of Semiramis on horseback, piercing a panther with an arrow, and close by, her husband, Ninus, attacking a lion with his lance." The historian adds that on the "burnt brick walls" of another palace, "on the other side of the river," there were likewise represented armies drawn up in battle array, and divers huntings, to the great diversion and delight of the beholders.

Josephus (A.D. 37-100) in the Antiquities of the Jews, III., VI., 4 (III., II., 22-6), writes:—"This Veil of the Holy of the Holies was very ornamental, being embroidered with every sort of flower the earth produces; and there was woven into it every variety of form that might be ornamental, excepting the forms of animals"; and in the Wars of the Jews, V., V., 4, (V., IV., 16-26):—

"The Veil of the Holy of Holies was a Babylonian curtain embroidered with blue, and fine linen, and scarlet and purple, and of a contexture truly wonderful. Nor was this mixture of colours without its mystical meaning, but was an image of the universe; for the scarlet enigmatically indicated fire; the flax, earth; the blue, air; and the purple, water. The fire and air having in their colours the suggestion of their significance; but the fine flax and purple having in their origin in the earth and the sea, respectively, the instigation of their symbolism. The curtain had also embroidered upon it all that was of mystery in the heavens, excepting the representation of the twelve signs (of the Zodiac) by living creatures."

Plutarch (circa A.D. 50-120) in his "Themistocles", 29, compares the conversation of a man to "embroidered tapestry which, when stretched out, showed its patterns, but when folded up, they are hidden and lost."

Arrian (circa A.D. 90-170) in his "Expedition of Alexander", VI., 29, describing the tomb of Cyrus, at Pasargadæ, writes:—"In the building was a golden coffin, wherein the body of Cyrus had been buried, and by the side of the coffin a couch, the feet of which were of gold, wrought with the hammer. A carpet of Babylonian tapestry, with purple rugs were laid upon it, also a Median coat with sleeves, and other tunics of Babylonian manufacture."

Pausanias (circa A.D. 138-180) in Laconica, XVI., tells us that every year the women wove a garment for the Apollo at Amyclæ, and called the place, in which they wove it, Chiton; in Eliaca, XI., that the sandals of the Phidian Zeus at Olympia, and the robe of the god, were of gold, and that on the latter various animals were represented, and of flowers, the lily; adding in chapter XII., that Antiochus IV. (B.C. 174-64) dedicated a veil, adorned with Assyrian weaving, and Phœnician purple, to the Temple of Olympian Zeus. In chapter XVI. he tells us that every fifth year, sixteen women of Elis wove a veil for the temple of Heré there, and held sports in her honour;

adding in Posterior Eliaca, XXIV., that in the forum of the city was a building called the "Sixteen Women," where they wove the veil of Heré: and in "Arcadica" V., he refers to the veil which Laodice, the daughter of Agapenor, sent to Tegea, for the temple of Pallas Alea.

Athenæus of Naucratis (circa A.D. 192-230), like the Latin writer Pliny, treats the subject systematically, and even more copiously than Homer, and I shall, therefore, only note those passages in The Deipnosophists, or "Banquets of the Learned," in which he either indicates the designs of the sumptuary tapestries of the period, or expressly discriminates them as coverings for the floor, or carpets proper, as we understand the word. In Book V., chapter 22, he states that the soldiers present at an entertainment given by Antiochus Epiphanes, wore purple cloaks, and many had them "embroidered with gold, or with figures of living animals"; in chapter 26 that, the king placed under the golden couches, used at the feast, "carpets of sea purple, the same on both sides"; and that on the couches were "embroidered rugs"; and that all the centre space, where the guests walked, was covered with "thin Persian rugs," having most accurate representations of animals embroidered on them; and in chapter 27, that the images of Victory borne in the Dionysiac procession at the same celebration, were clad in tunics embroidered with figures of animals; in Book VI., chapter 67, that a young Paphian spread his couch with "a Sardian piled carpet"; in Book XI., chapter 55, he quotes some verses from Hipparchus, referring to "a delightfully embroidered Persian carpet having some Persian figures, and preposterous shapes of Persian griffins, and such like beasts worked on it": In Book XII., chapter 8, he again mentions "Sardian pile carpets"; in chapter 24 of the same Book, he refers to "the flowery robes" of the Iapygians; in 25, to "the embroidered tunics" of the Sybarites; in 29, to the Persian stuff called "actæa," all over-diapered with "golden millet seed"; in 40, to a Phrygian robe embroidered with flowers; and in chapter 50 of the same Book he gives his well-known description of the Chlamys of Demetrius:—"It was of a brilliant tawny colour, with a representation of the heavens woven on it, the stars and the twelve signs of the Zodiac being all wrought in gold." And in 54 states that at the extraordinary connubial entertainment given by Alexander the Great, when he took Darius prisoner, the tents in which it was held were furnished in the most magnificent manner, "with sumptuous garments and cloths" for the guests, and were spread with cloths of purple and scarlet interwoven with gold"; and that the pillars supporting the tents were hung about with "costly curtains embroidered with figures of animals."

Philostratus (circa A.D. 217), the author of Imagines, in his life of Apollonius, of Tyana, states, I., 25, that the latter [he died A.D. 97], when in Babylon, where he stayed for some months, described the vestibule, rooms, and halls, and corridors of the "royal palace" there as having some work with silver. and some with gold wrought curtains * * * the subjects depicted on these tapestries being illustrative of the Hellenic myths (and apparently the Persian invasion of Greece), for "one could see the Hellespont bridged, and Athos pierced, and Athens occupied." He is the last Greek writer that needs be cited here.

(To be continued.)

GENEVA INTERNATIONAL FOOD CONGRESS.

By Loudon M. Douglas,
Lecturer on the Meat Industry, Edinburgh.

The first Congress of an international character which has lately been held at Geneva will be memorable because of the wide-spread interest it evoked. The idea of such a congress has often been in the minds of those associated with food supply, but the standards vary so much in different countries that at the outset it may be admitted that the difficulty of meeting upon some common ground has so far prevented international action. The value also of any resolutions passed must, for the greater part, be of an entirely academic character, inasmuch as it is clear that indiscriminate voting at such a congress on any specific resolution must be unequal, and the nation with the preponderance of representatives present must control the issues.

To be of any value, therefore, such congresses must appoint an equal number of delegates who have power to vote, and it might be arranged to protect the interests of minorities by giving them power to co-opt representatives from other nations so as to equalise their voting power.

The Congress, which was held at Geneva from 8th to 12th September inclusive, under the auspices of the Society of the White Cross of Geneva, owes its origin to Frenchmen, and Mr. Ruau, the French

Minister of Agriculture, attended its deliberations, and also outlined his own and presumably his Government's attitude in relation to the food supply. The fact that out of the 400 odd delegates present from all countries some 350 were French, serves to illustrate the point that, voting upon any resolution under such conditions could not be described in any sense of the word as representative of international opinion.

The primary object which the society hoped to attain is described in the title, which states that it exists for the repression of frauds in food and pharmaceutical preparations. With such a rôle it will be admitted that it has a vast field of activity before it, but the political element must be suppressed, otherwise it is quite clear that such a society may be made simply the tool of whichever country cares to exploit it the most.

There were twenty-nine different nations represented, but some of those had only a very limited number of delegates present, and many were quite unofficial, having come on their own initiative. This was noticeable with regard to the United Kingdom, which was not officially represented, although the Local Government Board had intimated that such a delegation would be sent.

The programme presented to the Congress was a large one, and dealt with many subjects in varying aspects, the discussions being largely made up of a mixture of science and commerce. The first day's proceedings were taken up with arriving at a definition of wine, but from the British point of view that is a subject which has only a local interest. The definition arrived at, however, may be of interest outside of wine-growing countries. Wine was defined as being, generally, the product of the alcoholic fermentation, complete or incomplete, of fresh grapes, or of the juice of fresh grapes. The signification of the definition lies in the fact that during recent years much sophistication has taken place in wines, more especially for export, with the consequence that the demand has gone down considerably, and over-production has caused much depression in the vine districts of both France and Spain.

Vinegar was also defined as the exclusive product of the acetic fermentation of wine, but that is clearly a definition suited to France or Spain and few other countries. Other definitions of an equally comprehensive character were given for cider, perry, beer, and liqueurs.

The second day was devoted to defining milk, butter, cheese, eggs, fats used for foods, and various commodities associated with "charcuterie," which is in reality the business of pork purveying and the manufacture of pork products. With it, however, is associated preserved and other provisions.

The definition of butter proved to be the one in which most interest was taken, and the discussions regarding what pure butter really was sometimes became very animated indeed. Finally, however, it was agreed that butter was a mixture of fatty matters exclusively derived from cow's milk after fermentation, and made either from whole milk, separated fat, or a mixture of both.

The use of preservatives in butter naturally occupied much attention, and while many of the French delegates opposed it, others as effectively supported it, and it was soon apparent that a large number, inclusive of the British delegation, were strongly in favour of a definition that boric acid preservative should certainly be allowed. Such opposition as exhibited itself seemed to be from a section which did not attempt to specify any objection from the point of view of health, but rather from the point of view that the use of preservatives favoured the manufacturer, as distinguished from the farmer or the co-operative societies. No decision, however, was reached, and the whole question was postponed to a future conference; to be discussed under the head of "manipulation."

The British section, through their spokesman, Dr. Tunnicliffe, pointed out that the descriptive text in which the attitude of the various nations to this matter was given, was entirely wrong in stating that the use of preservatives in the United Kingdom was prohibited, and that, on the contrary, it was allowed by the responsible department of State up to half per cent. A further discrepancy in this definition also appeared in the absence of any reference to the allowable percentage of water. On the whole, the matter was left in a very unsatisfactory condition, and it may be assumed that at the next congress, the necessity for boric acid as a preservative in addition to salt, will not only be recognised as desirable, but will be declared to be essential in all butters which have to be kept for any length of time beyond two days.

Cheese was defined as being the product of whole milk treated in the usual manner, but, of course, such a definition can have no weight whatever. The milk from which cheese is made varies considerably, as does also the recognised fat contents of cheese, and it will need much greater precision in definition before a clear understanding can be arrived at. Eggs again, were only entitled to be described as fresh, when not submitted to any process of preserving, and oils and other fats did not attain any more definite descriptions. Frozen meat was placed in the category of preserved meats—a definition which will hardly be accorded general approbation, and sausages were only entitled to be described as "pure," when free from all other ingredients except meat, pork or veal, in addition to the seasonings. They ought not to contain any greater percentage of moisture than the natural moisture of the ingredients. Of the other articles in the same class, none call for any special notice except salted meats, which were defined as being made from meats salted exclusively with commercial salt, with the addition of variable quantities of saltpetre and sugar. The inclusion of such a preservative as saltpetre may be regarded as indicating that the principle of using other preserving agents besides salt is

unavoidable, and in this connection the general opinion was that it will be found impossible to inhibit the production of certain ptomaines without the use of boric acid or other similar preservative.

The manufacturers of cocoa seem to be very much divided as to what that article really is, as, judging from discussion, the partisans of the use of alkaline carbonates maintained successfully that the addition of such chemical products did not interfere with the purity of the substance. As with cocoa and its cognate productions, so with tea and coffee.

In the departments of mineral waters, pharmaceutical preparations, and the unification of analytical methods, it would seem to be rather difficult to obtain such definitions as would be acceptable to all countries, as the practice must necessarily be governed by local tradition to a great extent, as well as the demands of the public. It is desirable, from the international point of view, that there should be unification of formulas, but such a result can hardly be expected from a mixed congress such as this, and indeed would seem to be altogether out of its province.

On the whole, the first International Food Congress may be said to have been interesting as an opportunity for the exchange of opinions on many questions affecting the food supply, and the very inconclusiveness of the discussions would seem to demonstrate the necessity for better organisation in the future. Possibly it may be found practicable to invite the various national representatives to the United Kingdom, so that the British nation may also have an opportunity of witnessing in detail what precautions are considered necessary in the handling of food in other countries.

It only remains to be said that the thanks of the Congress are due to the secretary, M. Fazy, and the local committee, for the excellent arrangements made.

As showing also the interest taken in the work of the society, it may be mentioned that a princely donation of 100,000 francs was given by Madame Paul Bolo, and many others of a lesser amount have also been received. In so far as the British Section is concerned, arrangements will be made in the future for a proper organisation, and permanent secretaries will be appointed to represent the manufacturers and the scientific sections of the United Kingdom, so that the next Congress, which will be held in Paris next year, will be attended by a British delegation worthy of the subject.

HOME INDUSTRIES.

The Hotel Industry.—A few years ago it seemed as if a considerable section of the well-to-do classes would abandon, more or less, the usual home life and live at hotels. It was believed, too, that London was becoming a more popular international touring place. Accordingly capitalists turned their attention more than they had done in the past to the construction of palatial hotels, and from being inadequately provided with first-class hotel accommodation, London is now among the most generously served in this respect. To some extent the forecast which led to the construction of the great hotels has been verified. The number of people who have taken up residential hotel life has become considerable, and continues to grow, and every year London seems to receive a larger number of American and Continental tourists. But you may have too much of a good thing, and the opinion grows that London is now over-stocked with hotels. However that may be, competition is undoubtedly very keen, and the principal hotels find it difficult, notwithstanding their very high charges, to maintain the dividends of their earlier years. For example, the accounts of one of the most fashionable and largest of these hotels, for the twelve months ended June last, show that the net profits have declined £21,000 as compared with those of the preceding year. In the case of another very large and central hotel, the net receipts are £16,000 lower, being £41,977 as compared with £58,309 last year; whilst a third, among the newest, and perhaps the most magnificent of them all, is in the hands of a Receiver. No doubt the American financial panic of last year prejudicially affected several of those large hotels which look to American custom for a considerable part of their profits, but the last six months must have been an exceptionally good time for London hotels, still the figures quoted, and others that might be submitted, seem to show that even the best of the hotel company shares are a rather speculative investment. For the present there appears to be no further room for London hotels of the character indicated, but it is quite possible that one or two new hotels run on somewhat different lines would do well, hotels, that is, intended for moderate purses, where good cooking and comfort could be counted upon.

Flannelette.—There has been a rather sharp controversy in the Press as to the danger of using flannelette. It is certain that when flannelette first came into extensive use, much of it was of a quality that was highly inflammable and, therefore, dangerous, but it is claimed that the sale of this dangerous material is now comparatively rare. The official statistics bearing upon the point hardly bear out this opinion, and mothers should be careful only to buy flannelettes which, after washing, can be held in the flame of a taper, or a candle, and will not ignite. Flannelette can be made non-inflammable at a trifling cost, and that being so, the Legislature might do well to consider whether it is not expedient to make it illegal to sell flannelette that is inflammable. At any rate, if highly inflammable flannelette is to be allowed to be sold, it should be made imperative to label it, "Inflammable," so that no person buying it may be induced to believe it "safe." Flannelette is warm, healthy, and most suitable for children, but the peril of

quick flaming flannelette is obvious, and requires to be guarded against. The dangerous grades are the commonest of cloths, which have been given a long nap, making the material exceptionally inflammable.

Weaving Shed Stoppages.—The *Burnley Gazette* of last week gives a full list of the local weaving mills which are closed indefinitely for want of yarn. They number 24, and contain 15,183 looms. Another mill with 1,624 looms, has been stopped for repairs for a fortnight, whilst the Stanley Mill, with 1,836 looms, was restarted a few days ago. It has been estimated (making allowance for sheds partially employed and running short time) that 28,000 looms are idle, or about 25 per cent. of the machinery in the town. Mr. R. Pollard, J.P., estimates that on the average 20,000 Burnley looms have been idle for a year, representing a loss of £300,000 in wages to beamers, winders, &c., and probably £300,000 to wage-earners in subsidiary trades. Mr. Pollard believes that the workers are "£1,000,000 worse off to-day than they were when the boom set in."

The Wool Trade.—It may be safely predicted that for some months to come the price of wool will be in striking contrast to the rates ruling last year. One expert puts the decrease in the export of wool from Australia and New Zealand this season at from 75,000 to 100,000 bales, but the general opinion is very different. It seems certain that much less wool will be sold in the colonial markets this season than was the case during last year. The opening sale at Melbourne was held a few days ago, and prices showed a fall of from 25 to 30 per cent. compared with the opening auction last October. Many very large owners who sold in the colonial market last year are now shipping their wool in slow sailing vessels at low freights for realisation in London, in the expectation that whilst the wool is at sea trade may improve and prices for the raw material rise. Already, at two auctions in Adelaide, about 80,000 bales have been sold, at prices which mean something like £400,000 less than the owners got for the same quantity of wool sold there at the first sales held there last season.

Insurance Developments.—Mention was recently made in these Notes of the new departure of the Alliance Assurance Company in issuing policies covering loss of profits occasioned through fire, the Alliance being the first of the older companies to undertake this class of business. Amongst other new departures, a scheme of insurance against insanity is announced by a company established last year. Under this scheme, an annual premium of ten shillings secures an annuity of £100 for a period not exceeding five years, while for fifteen shillings per annum, the maximum period is extended to ten years, and for an annual payment of twenty shillings, the annuity is payable during the whole term of insanity, until death. Larger indemnities may be obtained during these respective terms by a proportionate increase in the premiums, and a considerable reduction is granted if the scheme is adopted in conjunction with a personal accident policy. It may be that in view of the continually increasing strain of modern life, and the fact that insanity is an economic disability not covered by other policies, there is room for an insurance of this description, but it is difficult to believe that there will ever be a considerable demand for it.

The Outlook in the Cotton Trade.—Probabilities point to an American crop of about 13,000,000 bales. The American Bureau gives 6,284,000 bales ginned up to October 26, which compares with 4,931,600 bales and 6,417,800 bales to the same date in the two big crop years of 1904 and 1906. Anyway, there is good reason to believe that there will be abundance of raw material. Unhappily, October has closed without a settlement of the dispute between masters and men, but there are signs of a growing desire to come to terms. In the six weeks of the strike, ended last Saturday, the operatives sacrificed in wages something like £900,000, the trade unions paid about £160,000 in lock-out allowances; subsidiary trades have already suffered seriously, and although the long continued absence of demand for yarn and cloth has helped traders to bear the strain of the stoppage, the losses of the employers are heavy. It is earnestly to be hoped that masters and men will soon get into touch and reach agreement.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 9...Surveyors, 12, Great George street, S.W., 8 p.m. Opening Address by the President, Mr. Howard Martin.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Arthur Fish, "Round the Tate Gallery."

TUESDAY, Nov. 10...Asiatic, 22, Albemarle-street, W., 4 p m. Rev. Canon Westcott, "Some Hindu Religious Orders of N. India."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. D. A. Matheson, "Glasgow Central Station Extension."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 p m. Mr. J. Henniker Heaton, "Penny-a-word Telegrams throughout the Empire."

WEDNESDAY, Nov. 11...Japan Society, 20, Hanover-square, W., 8½ p m. Mr. Charles Holme, "The Pottery of the Cha-no-Yu."

United Service Institution, Whitehall, S.W., 3 p.m. Lieutenant A. C. Dewar, R.N., "Battle Tactics of Single Line."

THURSDAY, Nov. 12...London Institution, Finsbury-circus, E.C., 6 p.m. Mr. W. Willett, "The Waste of Daylight."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Inaugural address by the President, Mr. W. A. Mordey.

FRIDAY, Nov. 13...Astronomical, Burlington-house, 5 p.m.

Anthropological, Theatre of the Civil Service Commission, Burlington-gardens, W., 8½ p.m. (Huxley Memorial Lecture.) Prof. W. Z. Ripley, "The European Population of the United States."

Journal of the Royal Society of Arts

No. 2,921. VOL. LVI.

FRIDAY, NOVEMBER 13, 1908.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One-hundred-and-fifty-fifth Session will be held on Wednesday Evening, the 18th of November, when an Address will be delivered by Sir WILLIAM H. WHITE, K.C.B., LL.D., F.R.S. Vice-President and Chairman of the Council. The Chair will be taken at 8 o'clock.

Previous to Christmas there will be five Ordinary Meetings, and one meeting of the Indian Section.

The following arrangements have been made :—

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock :—

NOVEMBER 25.—"The Goldfields of Eastern Peru and Bolivia." By Sir MARTIN W. CONWAY, M.A., F.S.A., F.R.G.S. Sir MARCUS SAMUEL, Bart., will preside.

DECEMBER 2.—"Mechanical Flight." By ERIC STUART BRUCE, M.A. WILLIAM NAPIER SHAW, Sc.D., F.R.S., will preside.

DECEMBER 9.—"Kinematography in Natural Colours." By G. ALBERT SMITH, F.R.A.S., and CHARLES URBAN, F.Z.S.

DECEMBER 16.—"London Milk Supply from a Farmer's Point of View." By PRIMROSE McCONNELL, B.Sc., F.C.S.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock :—

DECEMBER 10.—"The Birds of India." By DOUGLAS DEWAR, I.C.S.

Papers for meetings after Christmas :—

"The Commercial Relations of France and Great Britain." By MONSIEUR YVES GUYOT.

"Railway Development in China." By ARTHUR JOHN BARRY, M.Inst.C.E.

"The Application of the Microscope to the Study of Metals." By WALTER ROSENHAIN.

"The Resources of Peru." By C. REGINALD ENOCK, F.R.G.S.

"Afforestation and Timber Planting in Great Britain and Ireland." By J. NISBET.

"Destruction of Vermin." By A. E. MOORE (Secretary of the Incorporated Society for the Destruction of Vermin).

"Gothic Art in Spain." By HENRY C. BREWER.

"Some Phases of Hinduism." By KRISHNA GOBINDA GUPTA (Member of the Council of India).

"Early Buddhist and Hindu Architecture and Sculpture." By Dr. A. A. MACDONELL (Boden Professor of Sanskrit, Oxford University).

"The Function of Schools of Art in India." By CECIL L. BURNS.

"The Problem of Indian Labour Supply." By SELWYN HOWE FREMANTLE, I.C.S.

"Ceylon, the leading Crown Colony, in 1909." By the HON JOHN FERGUSON, C.M.G.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock :—

January 28, February 25, March 25, April 29, May 27.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

February 2, March 2, April 6, May 4.

APPLIED ART SECTION.

January 19, February 16, March 19, April 20, May 18.

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

OSCAR GUTTMANN, M.Inst.C.E., F.I.C., F.C.S., "Twenty Years Progress in Explosives." Four Lectures.

November 23, 30, December 7, 14.

G, L. ADDENBROOKE, M.I.E.E., "Electric Power Supply." Three Lectures.

January 18, 25, February 1.

LEON GASTER, A.M.I.E.E., "Methods of Artificial Illumination." Four Lectures.

February 15, 22, March 1, 8.

GEORGE GERALD STONEY, M.Inst.C.E., "Steam Turbines." Three Lectures.
March 22, 29, April 5.

F. W. LANCHESTER, "Aerial Flight." Three Lectures.
April 26, May 3, 10.

JUVENILE LECTURES.

Two Lectures suitable for a Juvenile audience will be delivered on Wednesday afternoons, January 6 and 13, 1909, at 5 o'clock.

THE ANTIQUITY OF ORIENTAL CARPETS.

By SIR GEORGE BIRDWOOD,
M.D., K.C.I.E., C.S.I., LL.D.

Ingens decorum omnium templum Mundus.
Senecæ Epistolæ, XC.

(Continued from p. 1059.)

TAPESTRIES IN LATIN LITERATURE.

Plautus (circa B.C. 254-184), the first of the Latin writers to be quoted in the present connection, in Mercator I., 1., where Charinus states that his father Demipho "had had a sight of the peplum" (spectavisset peplum), alludes to the great Panatheniac Festival, at which the saffron coloured veil, or robe (see above Euripides, in Hecuba, and in Iphigenia in Tauris), woven by the noblest maidens of "the City of the Violet Crown," was hung from the mast of a ship on wheels, and so borne in triumph, up the Acropolis, to the Temple of Athene Polias.* In Aulularia, III., 10(5), he explicitly mentions, through the mouth of Megadorus, a Phrygio, or "embroiderer;" and the patagiarii, or dealers in figured tunics for females, that is the tunic ornamented round the neck, and down the front, with a purple, or golden, or embroidered edging (patagium), pretty much in the way the tunic for males among the Romans was bordered with the clavus. In Menaechmi II., 4. (II. 4) he again mentions a Phrygio, or "embroiderer." In Pseudolus, I., 2, he makes Ballio threaten his slaves with so sound a hiding that not even Campanian coverlets are covered so well, nor purple Alexandrian carpets, figured with beasts :—

"Ut ne peristromata quidem aeque picta sint Campanica,
Neque Alexandrina beluata conchyliata tapetia."

Finally in Stichus, II., 3, Pinacium enumerates among the purchases of Epignomus, Babylonian coverlets and needle-worked carpets :—

"Tum Babylonica peristromata consutaque tapetia."

Lucretius (B.C. 95 to circa 52), in Book IV., lines 75-76, a passage of great interest to the scientific photographer, speaks of the actors and audience in large theatres being coloured by the yellow, and red, and dark blue awnings spread over them :—

"Et volgo faciunt id lutea russaque vela,
Et ferrugina."

Again, in line 1029, he refers to Babylonian coverlets of surpassing splendour :—

"Cum Babylonica magnifico spendore rigantur;"

and elsewhere to estates being "wasted on," literally "turned into Babylonian textures" :—

"Babylonica fiunt."

Catullus (B.C. 87 circa 47), in his poem on "The Marriage of Peleus and Thetis," devotes lines 50-266, to a minute description of the coverlet of their nuptial couch, wrought in threads of deftest sleight with the figures of the men of yore and their heroic deeds :—

"Haec vestis priscis hominum variata figuris,
Heroum mira virtutes indicat arte."

With wondrous art it depicted the tragic story of Theseus and Ariadne, and thus splendidly decorated, the spreading coverlet enfolded the couch with its drapery :—

"Talibus amplifice vestis decorata figuris,
Pulvinar complexa suo velabat amictu."

It was, in short, a curtain like the *purda*, or veil used among the natives of India, to screen the women of a family from the sight of the men. After the young men of Thessaly had satisfied themselves with gazing on it, they made room for the Gods :—

"Quae postquam cupide spectando Thessalia pubes
Expleta est, sanctis coepit decedere Divis."

Virgil, B.C. 70-19, in Georgics III., 25, sings of British captives at a theatre, supporting an awning inwoven with the scene of their own defeat :—

"Purpurea intexti tollant aulaea Britanni."

In Æneid I., 697, he seats Dido on a throne, under "a superb awning" (aulaeis superbis). In III, line 467, among the presents of Helenus to Æneas, he names a corslet, wrought as a sort of chain armour, in "gold of triple thrummed" (auroque trilicem, *cf*: V., 259, and VII., 639, and XII., 375); and in lines, 483-485 of the same Book, Andromache brings forth for Ascanius vestments wrought in figures of gold, a Phrygian chlamys, and other labours of the loom :—

"Fert picturatas auri subtemine vestes,
Et Phrygiam Ascanio chlamydem . . .
Textilibusque onerat donis . . . ."

In IV., 137, Dido appears attired in a

* Cf. Iliad II., 546-51, and Odyssey vii., 81.

Sidonian chlamys (chiton), with an embroidered border :—

"Sidoniam picto chlamydem circumdata limbo."

In VII., 277, the swift horses of the Trojans are caparisoned with purple, and embroidered tapestry :—

"Instratos ostro alipedes, pictisque tapetis."

In VIII., 659-61, he describes the Gauls as golden haired, their vestments of gold, and shining in their gold "striped" (virgatus) shags, and their white necks hung with (torques of) gold :—

"Aurea caesaries ollis, atque aurea vestis ;
Virgatis lucent sagulis ; tum lactea colla
Auro innectuntur."

And in IX., 325-6, he represents Rhames, at the moment Nissus slaughters him, as lying on high raised carpets, snoring out the night :—

"qui forte tapetibus altis
Exstructus toto proflabat pectore somnum."

Horace, B.C. 65-8, in his Satires, II., 4, 83-4 exclaims :—"What, should you sweep mosaic pavements with a filthy palm broom, and throw Tyrian carpets over your unwashed couch !"

"Ten' lapides varios lutulenta radere palma
Et Tyrias dare circum inluta toralia vestes : "

and in his Epistles, I., 5, 23-4, in inviting Torquatus to dinner, informs him, that there shall be a clean carpet for his couch, and a clean napkin for his hands :—

"Ne turpe toral, ne sordida mappa
Corruget nares."

Tibullus, B.C. 54-18, in I., I., 65 (I., II., 77-8) apostrophising Delia, protests that without her favouring love, in vain is it to lie on a Tyrian couch, and in vain are soft down and richly dyed "tapestry" (stragula) to induce sleep :—

"Nam neque tum plumæ, nec stragula picta soporem
Nec sonitus placidæ ducere possit aquae."

Propertius, circa B.C. 51, in I., XIV., 19-22 sings of Venus that, she scruples not to enter a house furnished with Arabian* [*i.e.*, Indian] luxury, nor fears to invade a couch of Tyrian dye ; and asks Tullus what relief do silken garments of varied tissue afford :—

"Illa neque Arabium metuit transcendere limen :
Nec timet ostrino, Tulle, subire toro !
* * * *
Quid relevant variis Serica textilibus."

In II., XIII., 22 (III., XIIIb., 22) he prays that when dead his bier may not be of ivory, nor his body laid on a luxuriously covered couch :—

"Nec sit in Attalico mors mea nixa toro : "

and in XXXII., 12-13 (III., xxxii., 11-12) in imploring Cynthia not to give up so much time to her devotions, and to afford him some of her company, he adds, despitefully, that perhaps Pompey's portico, with its shadowing columns, and magnificently decorated with purple awnings, palls upon her :—

"Scilicet umbrosis sordet Pompeia columnis
Porticus aulaeis nobilis Attalicis."

In III., VII., 49-50 (IV., VII.) he describes his young friend Pætus, as lying in a chamber of cedar, or Orician terebinth, his head supported on a downy pillow of many colours :—

"Effultum pluma versicolore caput."

In IV., I., 15 (V., I., 15), he refers to the bellying awnings of the Roman theatres :—

"Nec sinuosa cavo pendebat vela theatro."

In VII., 46 (V., VII., 46) to Nomas, once a common street-walker, but now trailing her gold wrought cyclas† over the ground :—

"Haec nunc aurata cyclade signat humum : "

and in VIII., 23 (V., VIII., 43) to Cynthia's "silk lined (or curtained) *eka*" (serica carpenta).

Ovid (B.C. 43—A.D. 18) in his Metamorphoses, in the fable, Book VI., of the contest in weaving between Arachne (whose very

* Compare Propertius II., III., 15, of Cynthia :—"Nec si qua Arabio lucet bombyce puella." Here Arabia may be China or India ; but whether the silk was from India or China, or came by way of Egypt ["Indici donum maris"] or Persia, it was brought into the marts of the Eastern Mediterranean through the intermediation of the Arabs. Similarly the Parthia of the Latin writers often includes Persia ; and their Serica, Central Asia ; and India, China ; their geography of all the Eastern countries to which the arms, and direct commerce, of Rome had not extended being extremely vague and vagrant. The jessamines are as characteristic of India as the tiger, the peacock, and the cobra, but they are popularly known in Europe, one as the Arabian jessamine, or the Tuscan, and another again as the Arabian, and a third as the American myrtle, the Azorean jessamine, and the Caffrarian jessamine ; and not one of them is known as the Indian jessamine, and simply because they were introduced at different periods into Europe through the countries after which they are specifically named. The botanical name of the genus is the Latinised form of the Arabic name, *yasmin*, of one of the Indian species. Sir Thomas Browne gives Cambay as a synonym of the American myrtle, but he has no thought, as one might suppose, of its coming from Cambay in Western India, far less of this seeming place name of it being a corruption of its Indian name *chambali*. These are not the only instances of how in her Natural History, her Folk Lore, and Arts, and Philosophy, India has been inadvertently robbed of some of her chiefest glories.

† This is the Persian *saqlatun*, and Mahratti *saklat*; words derived from the Sanskrit *saktat*, the bright circle of the moon ; a word connected with the Greek *kûklos*. The English word scarlet comes directly from the Mahratti *saklat*.

name is the Semitic word *arag*,* "to spin") and Minerva, gives, in lines 70-128, two of the most interesting and instructive descriptions of tapestries that have come down to us from classical times. Pallas covers the field of her web with the scene of the trial of Mars on the Areopagus at Athens, by "the twice six celestial Gods," on his accusation by Neptune of having slain Halirrhothius. And in each corner of the field she wrought an ominous representation of some previous contest between presumptuous mortals and the uudying deities. The first corner contained the story of the metamorphoses of Rhodope and Haemus; the second of Gerane the queen of the Pygmies; the third of Antigone the daughter of Laomedon King of Troy; and the fourth of Cinyras and his daughters. And she surrounded it with a border of olive leaves:—

"Circuit extremas oleis pacalibus oras."

The Mæonian nymph delineates her tapestry with the symbolical amours of the Gods; to all of whom she gives their own likenesses: and she bordered it with flowers, interwoven with trailing ivy:—

"Ultima pars telae, tenni circumdata limbo,
Nexilibus flores hederis habet intertextos."

The "field" of the first tapestry with its "filling" and corner "lozenges" is characteristically Persian; and the borders of both are in the purest style of classical decorative art, and should be reproduced by modern European carpet manufacturers of scholarly taste; while the central pictorial scenes are not altogether objectionable in textile fabrics intended to be hung between pillars, or against walls, and thus to serve in part as paintings.

In the same Book of the Metamorphoses, lines 576-577, Ovid says of Philomela, that she skilfully hung a warp of "barbarian design" in the loom, and interweaving purple with white, discovered the villany of Tereus to his sister Procne:—

"Stamina barbarica suspendit callida tela:
Purpureasque notas filis intexuit albis."

In the Ars Amatoria, I., 103-4, the poet states that in the time of Romulus, neither did curtains hang over the marble theatre, nor was the stage suffused with liquid saffron:—

"Tunc neque marmoreo pendebant vela theatro
Nec fuerant liquido pulpita rubra croco."

* In the previous lines, 54-8, the whole process of weaving is fully and accurately described:—

"Et gracili geminas intendunt stamine telas.
Tela jugo vincta est; stamen secernit arundo:
Inseritur medium radiis subtemen acutis;
Quod digiti expediunt, atque inter stamina ductum
Percusso feriunt insecti pectine dentes."

Pliny (A.D. 23-79) in Book VIII., chapter 73 (48) writes:—"Thick flocky wool has always been esteemed for the manufacture of carpets (in tapetis) from the earliest times. It is quite clear from what we read in Homer that they were in use in his time. The Gauls embroider (pingunt) them in a different manner from that in use among the Persians (aliter Parthorum gentes, an allusion to pile carpets). The refuse of the wool (from weaving and felting) is used for stuffing mattresses, an invention, I fancy, of the Gauls." Again, in chapter 74 (48) he writes:—"The royal waved toga worn by Servius Tullius, now in the Temple of Fortune, was woven by Tanaquil. She was the first who wove the straight tunic (rectam tunicam), such as our young men wear with the plain toga; and newly married women also. Fenestella informs us that smooth togas, and Phrygian togas (togas rasas Phrygianasque) began to be used in the latter part of the reign of Augustus. The bordered toga (praetexta) had its origin among the Etruscans. I find the striped toga was first used by the Kings (trabeis usos accipio reges). Embroidered garments (pictæ vestes) are mentioned by Homer, and in this class originated our triumphal robes. The Phrygians first used the needle for this purpose (that is to say in the opinion of the Romans), and hence this kind of garment obtained the name of Phrygionian. King Attalus, who also lived in Asia, invented the art of embroidering in gold, from whence these garments have been called Attalic.* Babylon was very famous for its embroidery in different colours (colores diversos picturæ intexere), and hence stuffs of this kind obtained the name of Babylonian. The method of weaving cloths with more than two threads (of the warp), was invented at Alexandria; these cloths are called polymita. It was in Gaul (it was really in Egypt and Mesopotamia) that they were first divided in chequers (scutulis dividere). Metellus Scipio, father of Cornelia, the beloved wife of Pompey) stated that even in his time Babylonian coverings for dining couches (tricliniaria Babylonica, the sets of three carpets, one for the top, and one for each side of the length of a room, used to this day in Persia) were selling for 80,000 sesterces (? £4,600), and the price of these of late (in the time of Nero), had risen to

* This is what the Romans supposed, but a second, and earlier, etymology of the denomination of this enriched stuff may be suggested in the Semitic *atalus* or *atlas* originally some heavy brocade, and now, almost exclusively, satin.

4,000,000 sesterces (?£23,000). The pretextae of Servius Tullius, with which the statue of Fortune, dedicated by him, was covered, lasted until the death of Sejanus, and it is a remarkable fact that, during a period of 560 years, they had never become tattered, or received injury from moth."

Silius Italicus A.D. 25-29, who elsewhere refers to "the superb webs of the Arabians," (Indians), and the "gold striped tunics" of the Gauls, in Book XIV., lines 655-60, speaks of Syracuse at the height of her glory as not needing to import bronzes from Corinth (Ephyra) nor to look for rivals in the art of manufacturing gold brocades, whereon the Babylonians produced the faces of men that seemed to breathe, nor to envy the purple of Tyre and Attalic stuffs, nor the webs of Egypt:—

> "Non aera juvabant,
> Quae scirent Ephyren, fulvo certaret ut auro
> Vestis, spirantes referens subtemine vultus,
> Quae radio caelat Babylon, vel murice picto
> Laeta Tyros, quaeque Attalicis variata per artem
> Aulaeis scribuntur acu, aut Memphetide tela."

Juvenal (circa A.D. 25-? 95) in IV, 122, refers to the stage-machinery of his time, and the boys caught up by it to the awnings:—

> "et pueros inde ad velaria raptos."

In VI., 227-28, satirising the faithless bride, he says she leaves the doors so recently adorned, the tapestry (vela) still hanging on the house:—

> "Ornatas paulo ante fores, pendentia linquit
> Vela domus."

In the following lines, 259-60, after deriding the manly airs such women often give themselves, he adds that these same women perspire even in the cyclas, and are oppressed by a slip of delicate silk:—

> "Hae sunt, quae tenui sudant in cyclade, quarum
> Delicias et panniculus bombycinus urit."

In IX., 105, he refers to the use of tapestry hangings for keeping out draughts:—

> "Vela tegant rimas:"

and in X., 38-39, describes the praetor, at the opening of the Circensian games, bearing on his shoulders the Tyrian (Sarra, now es Sur) hangings of his embroided toga:—

> "In tunica Jovis, et pictae Sarrana ferentem
> Ex humeris aulaea togae."

Martial, A.D. 43 to 104, in II., XVI., says of Zoilus that the tapestries (stragula, cf; XIV., CXLVII.) on his couch are the cause of his fever:—

> "Zoilus aegrotat, faciunt hanc stragula febrem.
> Si fuerit sanus, coccina quid facient?
> Quid torus a Nilo? Quid Sidone tinctus olenti?"

In VIIII., XXVIII., 17-18, he says of the toga presented to him by Parthenius, that he would not prefer to it the embroided stuffs of Babylon, decorated with the needle of Semiramis:—

> "Non ego praetulerim Babylonica picta superbe
> Texta, Semiramia quae variantur acu:"

and in XIV., CL., occurs the couplet, already quoted, on an ornamental coverlet:—

> "Haec tibi Memphitis tellus dat munera; victa est
> Pectine Niliaco jam Babylonis acus."

Petronius Arbiter, A.D. 54-68, VI., describing Trimalchio's feast, says that presently the servants came in and "spread tapestry on the couches" (toralia proposuerunt toris); and, in VIII,, quotes a fragment from Publius Syrus, comparing the glory of an embroided Babylonian shawl (amictus) with that of a peacock's tail—

> "Tuo palato oculosus pavo nascitur
> Plumato amictus aureo Babylonico,"

Lucan, circa A.D. 65, in II., 354-64, writing of the private re-marriage of Cato with Marcia, says that she wore no girdle of gems, no necklace, no saffron veil, no turreted crown, nor was the threshold of the house hung with garlands, and the door posts with white fillets (*torun* of Hindus of Bombay), nor were there the usual torches, "nor did the couch stand on high with its ivory steps, nor was its coverings variegated with embroided gold" (et picto vestes discriminat auro). In X., 125-26, of the coverlets of the couches used, at the entertainment given by Cleopatra to Cæsar, he says "a part shines embroidered (plumata) with gold, a part fiery with Kermes, as is the manner of mingling the threads in Egyptian looms:"

> "Pars auro plumata nitet; pars ignea cocco,
> Ut mos est Phariis miscendi licia telis."

Lines 141—3 of the same book, describing the appearance of Cleopatra herself, have already been quoted, but will bear repetition here:—

> "Candida Sidonio perlucent pectore filo,
> Quod Nilotis acus percussum pectine Serum
> Solvit, et extenso laxavit stamina velo."

Quintus Curtius, circa A.D. 100, III., III., 18, states that the robe of Persian nobles were adorned in gold, with "hawks affronted," (pallam auro distinctam, aurei accipitres, velut rostris inter se corruerent, adornabant).

Apuleius, A.D. 125-75, makes several references to curtains, embroidered cushions, and other tapestries, and to silken umbrellas, robes, and other articles of dress: but the only passages I shall here quote are two, both in Book XI., illustrating the symbolical designs of the sumptuary textile manufactures of his time.

The first describes the vestments in which the goddess Isis appears to Lucius :—" Her robe (prætexta), woven of fine flax (bysso tenui), was of many colours ; now shining white (nunc albo candore lucida), now yellow as the crocus (nunc croceo flore lutea), and now flaming in crimson (nunc roseo rubore flammida). But what fixed my gaze most of all was her mantle of deepest black, and resplendent glossy lustre (palla nigerrima, splendescens atro nitore). Glittering stars were dispersed along the extremities of the garment and over its whole surface, while in the midst a moon of two weeks old breathed forth its flaming fires."

The second passage describes the mantle worn by Lucius at his initiation as a priest of Isis :—" A rich mantle (pretiosa chlamyda) descended from my shoulders down my back to my ankles, and on whatever part of it you looked there was something to arrest your attention in the animals with which it was embroidered in various colours (colore vario circumnotatis insignibar animalibus). Here were Indian serpents, there Hyperborean Griffins (hinc dracones Indici, Inde Gryphes Hyperborei), which the other world (mundus alter) generates in the form of a beast with wings. The persons devoted to the service of the divinity call this the Olympic stole."

Ammianus Marcellinus, A.D. 333-95, the last of the classic Latin historians, writes, XIV., VI., 9, of the vices of the Romans of his time :—" Others glory * * in their splendid apparel, * * * showing by the constant wriggling of their bodies, and, particularly by the waving of the left hand, their anxiety the more conspicuously to show off the multiform figures of animals embroided (effigiatæ in species animalium multiformes) on their long fringed tunics ;" and, XXIV., VI., 3, of Julian's invasion of Assyria :—" After our fatigues, that we might enjoy some seasonable rest, we encamped in an open plain, rich with trees, vines, and cypresses, in the middle whereof was a shady and delicious pavilion, having all over it, according to the fashion of the country, pictures of the king slaying wild beasts in the chase ; for they never paint, or in any way represent anything, except different kinds of slaughter and war" (varias caedes et bella).

Claudian (circa A.D. 395), the last of the Latin classic poets, in his Panegyric on the IVth Consulship of Honorius, says of the magnificent toga of the young Caesar that, " Tyre provided its purple dye, China its woof of silk, and India the gems that weighted it" :—

" Tribuere colorem
Phoenices, Seres subtegmina, pondus Hydaspes : "

And in his Rape of Proserpine the description of a tapestry recalls those immortalised by Virgil, and Catullus, and Euripides.—I am at present unable to give it in the original, and translate it from memory. " She (Proserpine) illustrated on the web with her needle the movement of the elements: Nature, the Mother of the Worlds, separating form and order from the formless void, and everywhere sowing the seeds of life in the ground yielding it ; the lighter particles floating upward, and the heavier falling downward ; and the shining ether, and the stars revolving round the pole, and the earth floating suspended in their midst, its sea covered with waves. The stars are golden, the sea swells in purple, the land rises in glittering gems, while skilfully woven threads foam in waves against every coast. One could see the sea-weed being torn from the rocks, and hear the resounding waves as they broke on the beach. Five zones she drew with her needle : the centre of heat, and on either side of this a temperate zone ; and beyond these the poles heaped with palaeocrystic ice, and numbed with cold, and wrapped in eternal gloom. She depicted also the realm of Hades, and, oh ! sad omen, her fated throne beside him."

Finally, Sidonius (C. Sollius Apollinaris) circa A.D. 500, Bishop of Auvergne, on the eve of the Middle Ages of the West, and of the Mohamedan conquest of the East, states in his Carmina, XXIII., 423-7, that at the Circensian games, silks, with palms, and crowns with necklaces (torques), were given to the successful competitors, and to the rest carpets :—

" Hic mox praecipit aequus Imperator,
Palmis Serica, torquibus coronas
Conjungi, et meritum remunerari,
Victis ire jubens, satis pudendis
Villis versicoloribus tapetas : "

And, in his Letters, IX., XIII., he thus describes a piece of tapestry :—" There we see Ctesiphon and Niphates, with wild beasts tearing across the web, infuriated by their skilfully pictured wounds, where from the blood flows unreal as the javelin that has pierced them. There also we see the fierce Parthian on his swift steed, now retreating, with his head turned back, and now advancing to hurl the javelin, putting to flight the wild beasts whose similitude he pursues."

CONCLUSION.

The foregoing archæological and literary survey makes it clear that carpets were probably manufactured in Egypt, and possibly in Chaldæa, long anterior to B.C. 2400; that, from the date of their earliest representations and descriptions to the present day there has been no material modification in the artistic and technical character, or even in the commercial denominations of Oriental carpets; that, from about B.C. 2400 to B.C. 800, the period of the commercial and artistic ascendancy of Egypt in Syria and Mesopotamia, and of the Egypto-Chaldæan art of the Hittites in Asia Minor, Oriental carpets were already well known in Eastern Europe; that, from about B.C. 800 to the close of the Persian wars against Greece, B.C. 480, the Oriental carpets known to the Greeks were still of the non-Hellenised archaic types of Egypt and Anterior Asia, displaying under the now predominating influence of Assyria over Syria and Egypt, the figures of the "Tree of Life," and the symbolical winged beasts of the Babylonians, in wonderful harmonies of glowing primitive colours; that, from B.C. 480, the date of the deliverance of Greece from the terror of Persia, to B.C. 146, the date of her subjugation by Rome, the period of the greatest activity of the genius of the Greeks, and signalised by the successive supremacies of Athens, Sparta, and Thebes (B.C. 480—331), the conquests of Alexander and the Diadochi (B.C. 338—280), and the brilliant reign of the Attalidæ at Pergamum (B.C. 280—133) that, during these 340 years the stromaturgic art of the East, conforming more or less completely to the standards of Hellenic taste, attained its highest excellence in design, as shown by the preference during this period of the conventionalised forms of flowers in decoration, to the strange monstrous shapes of winged bulls and lions, and eagle-headed men, the "high" seraphim, and "mighty" cherubim* of the Babylonians; and that, from the capture of Corinth, by Mummius (B.C. 146), to the overthrow of the Western Roman Empire by the barbarians (A.D. 476), and the invasion of the Eastern Empire by the Saracens (A.D. 720—39), there occurred, under the materialising influence of the supremacy of Rome in the Mediterranean and over Anterior Asia, a gradual degradation in the manufacture of Oriental carpets, not indeed in their technical characteristics, including their superb colouring, but in their intrinsic artistic qualities; for we now observe in their decoration, not only the recrudescence of unnatural animal forms that had already lost all their meaning, but the wholly incongruous introduction of landscapes and even portraits.

It is to the carpets of this, the debased Roman period of classical art, that Philostratus, who lived in the third century A.D., vividly refers in his Imagines, II., 31.—"We recommend the artist, not for his close imitation of the king on his peacock throne—of his tiara, and robe and tunic—figured with the fanciful animals the barbarians embroider on their clothes, but for the fine drawn gold so deftly intertissued with the web."

The carpet manufacture of the West laboured down to the middle of the present century under the disastrous effects of this Roman corruption of sumptuary art; but in the East it was suddenly saved from further deterioration by a most providential conjunction of circumstances, namely, the rapidity with which in the seventh and eighth centuries A.D., the Saracens overran the Sassanian Persian Empire, and the Syrian and African provinces of the Eastern Roman Empire, enforcing wherever they settled the peremptory interdiction by their new faith of the use of animal forms in decoration, and even of floral forms, unless conventionalised to an almost bare geometrical delineation, and the facility with which the plastic Greeks in Syria, Egypt, and Persia, at once, under compulsion of their new masters, adapted the degenerated arts of the Eastern, or Lower Roman (Byzantine) Empire to the religious principles, and social and domestic necessities of Islam.

There was, indeed, nothing sudden, any more than accidental, in this happy association of apparently disconnected circumstances, for it is one of the most striking illustrations to be found in human history, of "the long results of time" directed to their patient and beneficent fulfilment by the determinate counsel and foreknowledge of God.

About the Christian Era, the Greeks had been brought in Phœnicia, Syria, Mesopotamia, and Persia, into familiar and uninterrupted contact with arts that had indeed already been modified by themselves, through the establishment in the fourth century B.C. of

* See I. Kings, VI., 29, 32, 35:—And he carved all the walls of the house (Solomon's Temple) round about with carved figures of cherubim (winged bulls, et cætera) and palm trees ("Trees of Life") and open flowers ("knop and flowers"); and Ezekiel, XLI., 18—"And it (the Temple of the Prophet's vision) was made with cherubim and palm trees, so that a palm tree was between a cherub and a cherub ("seraph beasts affronted"). Compare also Ezekiel, XL., 18-26, and II. Chronicles, III., 5-17.

the Macedonian dominions of Alexander the Great, and the Seleucidæ, and the Lagidæ, over Anterior Asia and Egypt, but which still, particularly in the building style of these countries, preserved traces, not to be found in Greece, or even in Italy, of the vague and barbaric grandeur of the Egypto-Mesopotamian temples and palaces of Chaldæa, Assyria, and Babylonia; wherein the architecture and subsidiary decorative arts of sculpture, pottery, painting, mosaic, tapestry, and furniture, (*kataskeué* as opposed to *epipla*) generally, have everywhere had their origin; and probably it was not less to the intimate intercourse of the Greeks, from the time of Alexander the Great and the Diadochi, with Anterior Asia, than to the universal influence of the ostentatious magnificence of Rome under the Cæsars, that we owe the vulgarity of the rankly luxuriant arts, including that of tapestry, of the Græco-Roman period.

But at the same time that Greece was thus being re-acted on by Asia, she was in turn modifying, and far more widely and deeply than under Alexander the Great, the local arts of every nation brought under her influence in the course of the conquests and the commerce of the Cæsars.

This inter-action between the West and the East produced, between B.C. 480 and 146, the Græco-Buddhistic, or pre-Byzantine art of Central Asia, Afghanistan, and the Punjab; between B.C. 332 and A.D. 284, the Coptic or pre-Byzantine art of Egypt; and between B.C. 226 and A.D. 652, the Sassanian or pre-Byzantine art of Persia.

Again, when classical art, in its later debased Roman form, sought a refuge in Constantinople (A.D. 328) from the barbarians who overthrew the Western Empire, it there, in the service of Eastern Christianity, and under the influence of Coptic, Sassanian, and Græco-Buddhistic art, transformed itself, between the sixth and twelfth centuries A.D., into the Byzantine art of Constantinople; of which a strong outpost was planted at Ravenna, in Italy (A.D. 568—752).

Then, on the Nestorian Greeks being driven, in the fifth and sixth centuries, from Constantinople, they fled into Syria, Persia and Egypt, and from Persia, where, as seceders from the Christian Church, now identified with the Eastern Roman Empire, they were hospitably received, they spread through Central Asia to the confines of China, and into India and Arabia; until in the fourteenth century A.D., their further diffusion was cut short by the incursions and persecutions of the Mongols, under Timur. They had carried with them from the first, the fructifying germs of Greek art; and, in the seventh and eighth centuries, were everywhere accepted by the Saracen Arabs as their architects and artisans; and limiting themselves, in conformity with the religious scruples of their employers, that were also in part shared by themselves, to the production of floral and geometrical ornamentation, they, on the foundations of Indo-Buddhistic, Sassanian, Coptic, and Byzantine art, created Saracenic art as the ultimate Oriental expression of Greek art.*

But if the keen perception of the Greeks for the beautiful, particularly for purity, and delicacy, and grace of line, served, at the critical moment, to deliver the sumptuary carpets of the East from the indecorum and grossness by which they were contaminated and oppressed during the later imperial Roman period, the resuscitation of their ritualistic status, which, of itself, powerfully contributed to their artistic regeneration, was wholly the work of the Saracens themselves. These carpets had lost much of their religious character in originally passing from Egypt, and Phœnicia and Lydia, into Greece; and, except for their continued use as the outer and inner veils of temples, they would appear, during the ascendancy of Macedon and Rome, to have gradually become entirely secularised in Europe.

The Saracen Arabs at once changed all this. They were deeply embued with the almost universal Asiatic sense of the unity and absolute inseparability of the spiritual and material lives of men; and with the corresponding, although not necessarily deducible feeling, that durable, precious, and beautiful things can only be rightly used in the service of man, in so far as they also are made to minister to the glory of God. To the devout Saracen Arab, Nature—whether in its universality or its particularity—is the City, the Garden, the Mountain, in a word, the Temple of God; and, like the men of every other Asiatic race that has helped to civilise the world, he insisted that this fact

* Analogously in the West, on Leo III. (Isauricus) A.D. 717, expelling the image worshippers from Constantinople, they, followed by the fugitives of A.D. 754, and of A.D. 830 and 869, sought a refuge in Italy, where under the patronage of Charlemagne, A.D. 768 to 814, they gave that direction to the architecture of the Christianised barbarians who had overthrown the Western Empire, which, notwithstanding the continuing vitality of the traditions of classical art in Italy and France, resulted in the development, between the ninth and sixteenth centuries A.D., of the sublime Gothic art of Mediæval Europe.

should be unequivocally recognised in all the arts that sustained and adorned his newborn life in God; so that whether a mosque was built for him, or a carpet woven, or a gem set in silver—or, as later, in gold—he required that it should be a symbol of the consecration of the whole creation of things, seen and unseen, to the glory of God in the Highest; and in this instinctive identification of the beautiful with the good (*to kalon kai agathon*),* of the holiness of beauty with the beauty of holiness, we perceive the ideal inspiration of the perfection of the Saracens' own excellency in the arts, quite independently of their obvious obligations to the masterful draughtsmanship and general manipulative dexterity of the Greeks.

It thus happened that the pictorial and scenic type of Oriental carpets of the Sassanian Persian Empire, and Lower Roman Empire, rapidly, in the seventh and eighth centuries, gave place to the new Saracenic floral type. Not that the former were ever entirely superseded, for to the present day they survive in Egypt, and yet more numerously in Persia, where these *thardwash* (*i.e.*, "beast-hunt,") or, as they are called in India,† *shikargah* (*i.e.*, "hunting ground") carpets, are still known under the traditional name of *Susangird*,‡ that is, of Susiana (Khuzistan), or again, the Persian Empire; for the word, *gird*, compare our "girdle," although it literally means "suburb," as in *gird-i-shehr*, "the suburb of the city," here has the wider meaning of the "vicinage," "region," "province," "empire"; as in *Daoudgird*—literally, "the ward of David," Mount Zion, and again, Jerusalem—but, in its largest sense, the "realm" or "Kingdom" of David. But the new, and severely conventionalised floral type, applied either as a diaper, or in the "Tree of Life" and "knop and flower" patterns, gradually prevailed; and as modified in the freer drawing, and more natural delineations of the Italianesque Abbasi carpets, it characterises the predominant denominations of modern Persian carpets; which may again be described as *Susangird* carpets, "cum floribus," instead of "cum historia," as in the pre-Saracenic times of the Chosroes, and Byzantine Cæsars. The more strictly geometrical patterns, originally introduced by the Saracens, now linger, in their crudest relicts, only among the Turanian and Negroid populations of the Central Asian and African limits of Islam; and simply through the incapacity of these races for the higher, floral styles of decorative draughtsmanship.

Yet, whatever their type of ornamentation may be, a deep and complicated semeiography originating in Babylonia, and possibly India, pervades every denomination of Oriental carpets. Thus the carpet itself represents space and eternity, and the general pattern, or "filling" as it is technically termed, the fleeting finite universe of animated beauty. Every

* Plato roundly says [Republic V. 452] that the man is a fool who judges the beautiful by any other standard than that of the good; and Aristotle expresses the same opinion [Nicomachian Ethics I. 6] with a more limited application. The most animating enunciation of the principle is made by Euripides in The Bacchae, as the refrain of the spirited Chorus 862–910:—"What is more beautiful than wisdom * * * * the beautiful is a joy for ever (*ho ti kalon philon aei*)," this line having, as recently suggested by Mr. Gilbert Norwood, in his Riddle of the Bacchae, undoubtedly inspired the first line of Keats' Endymion—

"A thing of beauty is a joy for ever,"—

if not indeed his treatment of the whole poem. But Keats restricts the principle as closely to æsthetic—almost sensuous—beauty, as Aristotle to ethical.

† The following are the designations of carpets known in India:—*basat* ("spread"), *farash* ("spread"), *gastardah* ("spread"), these three being general terms for carpets; *harami* ("holy"), the chief carpet in a room; *sar-andaz* ("head-placed"), the carpet placed at the head of a room; *barikah* ("narrow"), the "strips" of carpet extending on either side of a room from the *sarandaz* to the opposite end of a room; the *sarandaz*, and two *barikah*, representing the "tricliniaria" of the Romans; *galim* or *kilim*, the large carpet (*harami*) placed in the centre of a room, and of a mosque; *sajjadah* ("place of prostration"), *jai-namaz* ("place of prayer") and *masalla*, ("adoration"), all names of prayer carpets; *susni*, a quilt-like covering embroidered with lilies (*susan*), and probably so called because originally imported into India from Susa, "the Lily" the summer capital of Achæmenian Persia; *thardwash* ("beast hunts"), or *shikargah* ("huntings"), carpets depicted, after the manner of those of ancient Persia, with beast hunts and similar scenes, and generically designated *Susan-gird*; *namad*, a felt carpet; *ru-farash*, the linen covering for carpets; *satrangi* ("four-colours") or *jamkhana*, ("assembly-room," *i.e.* sitting-room, or tent carpet) a chequered, or striped, carpet, generally of cotton; *dari* (literally "twill," by usage "door" *i.e.* *dwar* rug), a small cotton carpet; and *tabsat* a coarse rug. *Namad* is a felted carpet, *takyananamad* being a felted carpet from Afghanistan, or Persia; in which latter country the *sarandas* and *barikah* are usually felts. I am also told that in Persia they distinguish between *galim* or *kilim* and *gali* or *kili* carpets, the latter being a woollen pile carpet, and the former a woollen pileless carpet, "the same on both sides." See Athenæus above. *Baluchi* is a term applied in India to carpets from Baluchistan, whether of wool or cotton.

‡ The Indian quilts embroidered with the conventionalised flowers of the white water lily are called *Susni*, a corruption, as I have already inferred, of the Persian *Susani*, "of Susa." The term may not impossibly be a corruption of the Persian *suzani*, meaning "needle" work, and, in this instance, specifically "embroidery": or at least it may have as much of *suzan*, "a needle," in its entymology, as of *susan*, "lilies," here referring to the city of Susa. But in the phrase *Susan-gird*, always pronounced by the Jews in Persia "*Suzan gird*," there is no reference to "needlework" or embroidery; that is to *suzan-kar*, or *kar-i-suzan*. The phrase means simply carpets of the style of the (Sassanian, or of the Achæmenian) Persian Empire. *Suzan* a needle is compounded of *su*, "appertaining to," and, *zan* "woman."

colour used has its significance; and the design, whether mythological or natural, human, bestial, or floral, all has its connotative meaning. Even the representations of men hunting wild beasts, have their emblematical indications. So have the natural flowers of Persia their symbolism wherever they are introduced, and generally following that of their colours. The very irregularities, either in drawing or colouring, to be observed in almost every Oriental carpet, and invariably in Turkoman carpets, are seldom accidental, the usual deliberate intention of them being to avert the evil eye, and to assure good luck.* The noblest of these allusive carpets, are everywhere the *harami* carpets, made expressly to be placed under the domes of mosques, and the *sajjadah*, of a much smaller size, made chiefly in Syria and Kurdistan, for the faithful of Islam to prostrate themselves on, when at prayers.

The latter are always of the colour distinguishing the order of dervishes, or faqueers, for whom they are primarily intended; as deep blue or black for the Rifaiyah, red for the Ahmadiyah, green for the Bahramiyah, and white for the Kadiriyah; and they invariably have, at one end, a well-defined representation of the *mihrab*,† or niche, in the centre of one of the walls of every mosque, marking the direction of the *kiblah* ("opposite"), or sacred point, towards which Orientals generally look when at their devotions, and which for Muslimun, is Mecca. This mimic *mihrab*, which usually enclosed a figure of "Tree of Life," is always directed, when the carpet is in use, towards Mecca. The Persian name of these carpets, is *jai-namaz*, or "the place of prayer"; and their Arabic name, *sajjadah*, literally, "prostration," meaning the place of prayer," and *masalla*, meaning "adoration."‡ It is radically the same word as *masjid*, or, in its corrupted English form, mosque, "the place of (public) prayer"; and the prayer carpet is often found to be designed on the general ground plan of the mosque, with its door way, and place for leaving the shoes of "the Faithful," and tank for ablutions, and pulpit, and cloisters, all indicated, in addition to the ever-present mihrab. In short, it would seem as if the mosque originated in the prayer carpet; and the first "house of God," apart from the overhanging branches of the trees that were primitively worshipped as gods, was possibly the carpet spread before some idol image of general resort among the tribes of the vast rainless, treeless, desert solitudes, lying between the valleys of the Nile, and the Tigris, and the Euphrates. Diodorus Siculus tells us that the Egyptians used carpets in this way; and stamped and hand-painted cotton cloths are still similarly used by the Hindus.

Thus, notwithstanding that daily familiarity with sacred things tend to dull the sense of awe that should ever be inspired by their presence, the abiding feeling, at the heart of hearts of every truly reverent Muslim, when standing on the *sajjadah*, can only be fitly expressed in the devout words of the patriarch, Jacob, at Bethel (Genesis xxviii., 17):—"This is none other than the House of God, and this is the Gate of Heaven."*

The spiritual exaltation of character whereby the Muslimun are pre-eminently distinguished, is altogether owing to their thus individually realising in everything around them the directly felt presence of the Deity; and nothing is more remarkable than the immediate effect of this habit of mind in developing the personality, and in every way raising the condition, of the convert from Paganism to their inexorable monotheistic faith. But we are here more interested in its elevating and refining influences on the arts inherited by them from their Saracenic predecessors.

The religious sense of the indivisible unity of the spiritual with the material world, of this perishing Earth of ours having also its part in the imperishable Paradise of God, illuminates the whole temporal life of man with the eternal light of heaven, and inspires every human work, of even the humblest handicraft, with that illusion of a higher reality, wherein is found not only the true perfection of art, but the most spontaneous, and the most congenial expression, the finite powers of symbolisation we possess can give to our conceptions of infinite beauty and goodness.

In saying this, it is not meant that art, here limited to "the fine arts" and "the applied

* See my "Introduction" to Mr. Vincent Robinson's book on Eastern Carpets (Sotheran), 1882, and (Quaritch) 1893: and for the full symbolism of the "Tree of Life" my Industrial Arts of India (Chapman and Hall), 1880.

† Derived, like the niches in Hindu temples, from the niches in which, in the ancient Buddhistic monuments of India, the image of Buddha is found placed. The Saracenic arch also obviously had the same origin, its characteristic curve being that of the cope of these niches over the shoulders, and above the head, of the contained image of Buddha.

‡ The red *sajjadah*, *jainamas*, or *masalla*, is used in Mohammedan countries for the conjuration of genii, and the adjuration, or exorcism, of demons.

* Compare Exodus iii., 5; Joshua v., 15; and Acts vii., 33.

arts," affords the highest mode of denoting the ultimate conception of religious truth included in the creeds or verbal symbols of Christendom and Islam; if for no other reason, because Christians for the most part, and Muslimun universally, have reached a level of culture above that at which graven images, and pictures and other graphic representations can be venerated, nay actually worshipped, as symbols of Deity. But there is in the heart of man an instinctive and imperative craving for communion,—actual colloquy,—with God, that is to bring "the Word of Life" into consciousness, that may, as it were, be seen, handled, and tasted, and which he as instinctively seeks to satisfy by the artifices of music, or painting, or sculpture, or language; and if it be admitted that language is the supreme medium of intercourse with God, for that very reason it is the less suited for the use of the generality of men, for whom music, and painting, and sculpture, devoutly directed, will always remain the most powerful means for drawing the soul towards, and absorbing it in the Deity; while it would have been more for the happiness of the world if, instead of scientifically investigating, and logically wrangling over, our religious conceptions, and embodying them in definite verbal formulas, that after all are an implied denial of their spirituality, and a ceaseless provocation to explicit questionings of their truth,—it would have been far better to have left them to the familiar symbolisation of the arts that have been the great historical vehicle for their transmission throughout the habitable globe, and everywhere the best understood of mankind.

Nor can it be denied that the supreme satisfaction of art lies in its spiritual significance; and that if this be wanting in any art, it is all vanity; the wretched vanity of the realistic painters the Greeks aptly described as "dirt painters" (*ruparographoi*). The eye is not satisfied with seeing, nor the ear with hearing, and art, void of its supernatural typology, fails in its inherent artistic essence, as well as in the divine sources of its sempiternal joy and glory. It is indeed the whole secret of the fascination exercised over us by the arts of ancient Egypt and Mesopotamia, and of modern India, the India of the Hindus, where the whole basis of life is still religious; as also by Saracenic art, for although the Muslimun repudiated the idolatrous symbolism of Paganism, they retained and, indeed, intensified its insuppressable, quickening spirit. It is the surpassing praise also of the ecclesiastical arts of the West, the arts, that is, of the historical Catholic Roman and Greek and schismatic Anglican Churches; for in the presence of these sacramental arts it is the majesty and glory of the whole creation of things, visible and invisible, that seems spread out before us, although it be but a carpet on which we look.

Of this transcendental art was the mystic Cestus ("Iliad," XIV., 214-19), or girdle of Alma Venus; which we may imagine to have been a web of lightest sindon [*i.e.*, "Indian" muslin] broadly striped throughout its length in diaphanous rose, and ivory white, and saffron, and azure, as if "Iris had dipp'd the woof";* and inwrought, at its ends, with conventional representations of the allurements of the senses, and, over its airily woven gossamer "field," with a delicate "filling" of flowers of the most exquisite grace of form, and the most refreshing sweetness of bloom, emblems of the eternal youth, and fragrance of untainted natural beauty and love.

> "Te Dea, te fugiunt venti, te nubila coeli,
> Adventum tuum; tibi suaveis daedala tellus,
> Submittit flores; tibi rident aequora ponti,
> Placatumque nitet diffuso lumine coelum."†

Such also were the sacred veils of the ancient temples of the gods commemorated by Euripides, and Josephus, and Pausanias; black, or purple, scintillating all over with the silver and gold of the glittering moon and her circle of radiant stars, each star in its own mansion revealing, within the foldings of the veil, depths beyond depths through the infinite abysses of space, and filling the heart of man with awe in the presence of the mighty rulers of the darkness and the night; or red, or saffron, or blue, dazzling with the brightness of the sun emblazoned in gold amid his twelve diurnal and annual stations, shooting forth on all sides the light of day, and in turn chasing from the mid heavens, the Fishes, the Twins, the Balances, and Capricorn, leading on Spring and Summer, Autumn and Winter, in his triumphant train, and rejoicing the heart of man with the sense of perennially renewed life, and immortality.

Thus antiquity, from its being nearer than we

* Milton's Paradise Lost, XI., 244. Compare Comus 83:—"These my sky robes spun of Iris woof."

† See the exquisite translations of these opening lines of the De Rerum Natura of Lucretius in Spenser's Faerie Queene, X., IV., 44, 45; from which I can here only quote the first two lines of stanza 45:—

> "Then doth the daedale Earth throw forth to thee
> Out of her fruitful lap abundant flowers."

are to the divine origin of things, was ever mindful to symbolise in its sublime art the truth of the conviction that the green circle of the earth, and the shining frame of the outstretched heavens, are but the marvellous intertexture of the veil dividing between the world we see, and the unseen, inscrutable world beyond. This is the reason of the vitality, the dignity, and the power of giving contentment, possessed by the arts of antiquity; with which, alas! the arts of the modern world of the West will never be endued, until they also become animated by the spirit of this pristine faith of every historical race of the Old World. "Vanitas est deligere quod cum omni celeritate transit, et illuc non festinare ubi sempiternum gaudium manet"; and for all the technical instruction that may be given, and all the luxurious illustrations of typical Eastern examples that may be published, no truly great carpet will ever be produced in Europe, until the weaver's heart is attuned to sing to the accompaniment of his ringing loom, and in grateful unison with every conjubilant voice of praise in heaven and on earth:—

"Sanctus, Sanctus, Sanctus, Dominus Deus Sabaoth!* Pleni sunt coeli et terra gloria tua! Gloria in excelsis!"

* The Vulgate translation of this triumphal hymn of the seraphim in Isaiah VI., 2, renders *tseboath* by exercitum, but the older translation of the Missal more correctly retains the Hebrew word (in its Hellenised form) sabbaoth, for it refers not to the armies of Israel but to the stars, "the host of heaven" (Isaiah XI., 26) "the camp of God" (Genesis XXXII., 2).

HOME INDUSTRIES.

The Cotton Trade Dispute.—On Friday last, masters and men met in conference, with the result that the lock-out is at an end. It will be remembered that the employers insisted upon a 5 per cent. reduction in the rate of wages as from January 1st next, the men objected, and the lock-out followed. Last week the men approached the employers, offering to consent to the 5 per cent. reduction if it was postponed until March, and to this the masters agreed. The seven weeks idleness of the mills has permitted the clearance of a large portion of the stocks on hand, and the acceptance by the men of the 5 per cent. reduction as from March next has affirmed the principle for which the masters were fighting, namely, that just as in good times they are expected to advance the rate of wages, so in bad times the workmen must consent to reduction. Under the Brooklands Agreement, arrived at after a 20 weeks' lock-out in 1893, no subsequent variation of wages was either to exceed or to fall short of 5 per cent. of the amount being paid at the time, and no change of any sort was to be made till after the lapse of a year from the last settlement of the question. The men will not, therefore, be able to claim an advance, however good trade may be, until after March 1910, and unless some better and more elastic system of settling trade disputes is devised and agreed to in the meantime, as may be the case. About 40,000,000 spindles were affected for seven weeks, so that the stoppage of production was not very much smaller than was the case in the 20 weeks, stoppage of 15,000,000 spindles in 1893, which ended in the framing of the Brooklands Agreement. Primarily the loss to all concerned, now that the lock-out has happily come to an end, is less than is generally supposed, for if there had been no lock-out the state of trade was such that the employers would have been compelled to run half-time during the fall of the year, and this would have meant the same length of stoppage but over a longer period. The danger was that feeling on both sides would become so inflamed that the quarrel would be fought to the bitter end. Happily wiser counsels have prevailed, and the conduct of the men has been excellent throughout the seven weeks that the mills were closed. It is gratifying to have it on the authority of Mr. C. W. Macara, president of the Master Cotton Spinners' Federation, that an automatic scheme for the regulation of wages is almost perfected.

Sir Christopher Furness's Scheme.—At a meeting last week of delegates of the trades unions concerned, it was agreed, after long discussion, to recommend the men to accept Sir Christopher Furness's proposal to the trades unions interested in the shipping industry of the North-East coast, for an experimental period of twelve months. It will be remembered that Sir Christopher Furness made alternate proposals, the first being the purchase of the shipyards of his company by the trades unions. This was not entertained, and probably it was not anticipated that it would be. The alternative scheme, now provisionally accepted, was that the members of the trades unions employed should become limited co-partners in the two shipbuilding yards belonging to the company. The initial condition was that the *employé* partners should prove their good faith by becoming holders of special *employés* shares, paying for such shares by a deduction of 5 per cent. from their earnings until the total amount of their shares was paid. For the 5 per cent. deduction so invested in the special shares they will receive, whether the company divides any surplus profit or not, 4 per cent. as paid interest. This arrangement will not interfere with a workman's freedom of action. If he leaves the company he will be able to sell his shares to his fellow *employés* at an assessed or arbitrated value. While the men, as *employés*, continue to work, they will be paid according to trade union regulations, and have the 4 per cent. fixed interest on their shares, and these will be

divided between them as holders of *employés'* shares and the holders of the ordinary shares in the company whatever sum there remains after the apportionments for 5 per cent. interest on capital, and after depreciation, reserve, and development funds have been provided, on the basis of their individual holdings, and in addition to the fixed maximum interest of 4 per cent. The scheme is one of profit sharing, with something of the principle of the premium bonus system, methods that hitherto have been looked at askance by the trade unions.

The Port of London. — It is stated that the Government will press forward with the Port of London Bill this session, but it is difficult to believe that it will become law this year. Introduced under the twelve minutes' rule, it has not as yet been discussed in the House of Commons; and its great importance, and the complexity of the interests dealt with, make it highly desirable that it should receive, as no doubt it will do, ample discussion before its third reading. The docks are to be taken over at a price of £22,487,676, including compensation to certain directors and officials, to be paid in port stock to be created, bearing interest at 3 and 4 per cent. The Port Authority to be created by the Bill will be given the control of the docks, the powers, rights, and liabilities of the Thames Conservancy below Teddington, and it will take over the duties of the Watermen's Company. But even then it cannot be said that it will be the one central authority controlling the port trade, for some 57 per cent. of that trade never enters the docks, and will, therefore, be outside the control of the new authority. It does not seem a satisfactory position that there should be one port authority controlling the docks whiie one-half of the port trade is in other hands. The opponents of the Bill—and they are numerous and influential—urge that either the wharves should be purchased as well as the docks, or neither. If there is to be one central authority, as is commonly supposed to be the intention of the Bill, the force of this contention is obvious. Again, the project to give the Port Authority power to levy charges on goods, although recommended by the Royal Commission, is a new departure of very great importance, and it may be taken that there will be prolonged discussion upon it. In these circumstances the Bill cannot be passed into law this session.

Women in Workshops.—The Secretary of State has issued an Order with regard to the overtime employment of women, which directs that the special exemption under Section 49 of the Factory and Workshop Act, 1901, by which the period of employment of women on certain days, and subject to certain conditions, be between 6 a.m. and 8 p.m., or 7 a.m. and 9 p.m., or between 8 a.m. and 10 p.m., shall be extended to the non-textile factories and workshops, or parts thereof, in which the following processes, or any of them, be carried on, viz., making of cardboard and millboard, the colouring and enamelling of paper other than wall papers, the stamping in relief of paper and envelopes, the making of postage stamps, stamped post-cards, and stamped envelopes, the making of Christmas and New Year cards and cosaques, the making of mince pies, mincemeat, and Christmas puddings, the bottling of beer, the making of boxes for aerated water bottles, the washing of bottles for use in the preserving of fruit, the making and mixing of butter, and the making of cheese, the making of fireworks, the calendering, finishing, hooking, capping, or making-up and packing of any yarn or cloth, provided that in Lancashire and Cheshire this exception shall not apply unless such processes are the only processes carried on in the factory, the warping, winding, or filling of yarn, without the aid of mechanical power, as incidental to the weaving of ribbons, the making-up of any article of table linen, bed linen, or other household linen, and processes incidental thereto; the making of bouquets or wreaths, or similar articles, from natural flowers or leaves; or process in which natural flowers or leaves are otherwise adapted for sale. But this permission is conditional upon there being in each room, in which overtime is being worked, at least 400 cubic feet of space for each person employed therein.

The Nottingham Lace Industry.—The dispute in the Lancashire cotton trade has not seriously affected the lace industry of Nottingham and district. Manufacturers had good stocks to work upon when the lock-out occurred, and these have lasted longer than would have been the case in ordinary circumstances, owing to the depression in the lace trade. About 25 per cent. of the members of the Amalgamated Society of Operative Lacemakers are now on short time, or out of work altogether. In some cases members of the amalgamation have exhausted their six months' trade union out-of-work pay. About 6 per cent. of the members are now receiving union benefit, although nearly one-third of the 3,000 members are only partially engaged, working from one to two or three days per week. This has helped the manufacturers to make their stocks of yarn last over a long period.

OBITUARY.

Sir Edward FitzGerald Law, K.C.S.I., K.C.M.G.—Major Sir Edward Law, a member of the Society since 1900, died at Paris on Sunday, 1st inst. He was born at Rostrevor, co. Down, in 1846, and passed through the Woolwich Academy, from which he was commissioned to the Royal Artillery in 1868. Early in his service he went to India, and served in the Sudan Campaign in 1885, with the commissariat and transport staff, receiving the medal and clasp, and the Egyptian bronze star, and commendatory mention in despatches. Attaining the

rank of Major in 1886, he entered the diplomatic service in the following year as Financial and Commercial Attaché at St. Petersburg. He filled several important diplomatic offices, and in 1900 he became financial member in Lord Curzon's Council in succession to the late Sir Clinton Dawkins. He resigned in January, 1905, and in the following year he was British Commissioner on the International Commission in Crete, and subsequently served as Censor of the Morocco State Bank. He was one of the three members of the executive committee appointed to organise and supervise the Indian section of the Franco-British Exhibition.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 16...Historical, Clifford's-inn-hall, Fleet-street, E.C., 5 p.m. Mr. Frederic Harrison, "The Earl of Chatham."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. W. S. Barclay, "Some Aspects of the River Parana and its Watershed: an Economic Survey."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. J. A. Gotch, "The Elizabethan House, as illustrated by contemporary Architectural Drawings."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. Beaumont, "A Tour in Central France, including the Cathedrals of Bourges and Tours."

TUESDAY, Nov. 17...Junior Engineers, United Service Institution, Whitehall, S.W., 8 p m. Inaugural address by Mr. James Swinburne (President-elect), "Available Energy."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. D. A. Matheson's paper, "Glasgow Central Station Extension."

Statistical, (at the ROOMS OF THE ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C.), 5 p.m. Sir Edward Brabrook, "Social Insurances."

WEDNESDAY, Nov. 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Meeting of the 155th Session. Address by Sir William White, Chairman of the Council.

Meteorological, 25, Great George-street, W., 7½ p.m. 1. Mr. Henry Harries, "Twentieth Anniversary of the German Meteorological Society held at Hamburg, September 28-30, 1908." 2. Mr. W. Makower, Margaret White and E. Marsden, "Investigation of the Electrical State of the Upper Atmosphere made at the Howard Estate Observatory, Glossop." 3. Captain C. H. Ley, "Balloon Observations made at Birdhill Co. Limerick, during July and August, 1908."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. Marshall D. Ewell, "The present status of Micrometry." 2. Mr. A. C. E. Merlin, "Note on a new growing cell for critical observation under he highest powers." 3. Prof. J. A. Thomson, '*Studeria*, a remarkable new Genus of Alcyonarians."

United Service Institution, Whitehall, S.W., 3 p.m. Colonel H. E. Rawson, "A New Principle in Weather Forecasting, and its Value in Naval and Military Operations."

THURSDAY, Nov. 19...Concrete Institute, at the Royal United Service Institution, Whitehall, S.W., 8 p.m. Mr. C. F. Marsh, "The Composition and Uses of Plain and Reinforced Concrete."

Linnean, Burlington-house, W., 8 p.m. 1. Prof. A. D. Imms, "A new Species Symphyla from the Himalayas." 2. Mr. Geoffrey Smith, "The Freshwater Crustacea of Tasmania, with Remarks on their Geographical Distribution." 3. Mr. Harold Wager, "The Optical Behaviour of Epidermal Cells of Plants." 4. Mr. C. T. Druery, "The Singular Growth of a *Scolopendrium*, in an Airtight Case." 5. The Rev. J. Gerard, "Photographs of a Yew-tree, showing Twin-like Growth." 6. The Rev. J. Gerard, "*Wistaria*, as affected by the direction of twining." 7. Miss A. L. Smith, "*Myxococcus pyriformis*, a British Species of Myxobacteriaceæ." 8. The Rev. T. R. R. Stebbing, "*Caverarularia obesa* (Milne Edwards) from Borneo."

Chemical, Burlington-house, W., 8½ p.m. 1. Messrs. F. L. Pyman and W C. Reynolds, "Meteloidine: a new Solanaceous Alkaloid." 2. Mr. V. H. Veley, (*a*) "The Affinity of certain Alkaloids for Hydrochloric Acid"; (*b*) "The Affinity Constants of Bases as determined by Methyl Orange." 3. Mr. E. C. C. Baly and Miss E. G. Marsden, "The Relation between Absorption Spectra and Chemical Constitution. Part XII. Some Amine Aldehydes and Ketones of the Aromatic Series." 4. Messrs. B. D. W. Luff and F. S. Kipping, "Organic Derivatives of Silicon. Part VIII. The Resolution of Disulphobenzylethylisobutylsilicyl Oxide, and the Properties of the Optically Active Acids." 5. Messrs. A. E. Dixon and J. Taylor, "Study of the Constitution and Properties of the Rhodanides of Inorganic Radicles" (Part I). 6. Mr. G. Barger, "The Action of Phosphorus Pentachloride on the Methylene Ethers of Catechol Derivatives III. The Cyclic Carbonates of Dichloro-ethyl- and Propylcatechol." 7. Messrs. G. Barger and A. J. Ewins, "The Synthesis of Thionaphthen Derivatives from Styrenes and Thionyl Chloride."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. E. B. V. Christian, "An Apology for the Suburbs."

Optical, 20, Hanover-square, W., 8 p.m. Presidential Address, "The Ophthalmological Value of the Foveal Angle," with a demonstration of a new instrument, by Mr. John H. Sutcliffe.

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Inaugural Address by the President, Mr. W. M. Mordey.

FRIDAY, Nov. 20...North-East Coast Institute of Engineers and Shipbuilders, Sunderland, 7½ p.m. General Meeting.

Art Workers' Guild, Clifford's-inn-hall, Fleet-street, E.C., 8 p.m. Paper on "Bewick's Landscapes."

Architectural Association, 18, Tufton-street, S.W., 7½ p.m. Mr. J. B. Fulton, "The Church of St. Sophia."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. 1. Dr. T. E. Stanton and Mr. L. Bairstow, "The Resistance of Materials to Impact." 2. Mr. F. W. Harbord, "Different Methods of Impact Testing on Notched Bars."

CONTRIBUTIONS TO THE READING-ROOM.

The Council have to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and other Periodicals.

TRANSACTIONS, &c.

Aeronautical Society, Journal.
African Society, Journal.
American Academy of Arts and Sciences, Proceedings.
American Chemical Society, Journal.
American Institute of Architects, Bulletin.
American Institute of Electrical Engineers, Transactions.
American Institute of Mining Engineers, Transactions.
American Leather Chemists' Association, Journal.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions.
American Society of Mechanical Engineers, Transactions.
Architectural Association, Journal.
Association of Engineering Societies (American), Journal.
Australasian Association for the Advancement of Science, Report.
Australian Official Journal of Patents.
Bagnères-de-Bigorre, Société Ramond, Bulletin.
Bath and West of England Society, Journal.
British Association for the Advancement of Science, Report.
British Dental Association, Journal.
British Fire Prevention Committee, Publications.
British Horological Institute, Horological Journal.
Brussels, Société d'Etudes Coloniales, Bulletin.
———, Travaux Publics de Belgique, Annales.
Canada, Royal Society, Proceedings and Transactions.
Canadian Institute, Transactions.
Canadian Patent Office, Record.
Canadian Society of Civil Engineers, Transactions.
Central Chamber of Agriculture, Agricultural Record.
Chartered Institute of Patent Agents, Transactions.
Chartered Institute of Secretaries, Organ of the Institute—"The Secretary."
Chemical Society, Journal.
Chicago, Western Society of Engineers, Journal.
———, Field Museum of Natural History, Publications.
Civil and Mechanical Engineers' Society, Transactions.
Cleveland Institution of Engineers, Proceedings.
Cold Storage and Ice Association, Proceedings.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, La Revue Polytechnique.
Geological Society, Quarterly Journal.
Glasgow, Royal Philosophical Society, Proceedings.
Haarlem, Koloniaal Museum, Bulletin.
Imperial Department of Agriculture for the West Indies, Publications.
Imperial Institute, Bulletin.
India, Geological Survey, Memoirs and Palæontologia Indica.
——, Government of, Agricultural Ledger.
Indian Meteorological Department, Monthly Weather Review.
Institute of Bankers, Journal.
Institute of Chemistry, Proceedings.
Institute ot Sanitary Engineers, Journal.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Gas Engineers, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Mining and Metallurgy, Transactions.
Institution of Naval Architects, Transactions.
International Catalogue of Scientific Literature.
Iron and Steel Institute, Journal.
Japan, College of Science, Imperial University, Journal.
Japan Society, Transactions and Proceedings.
Junior Institution of Engineers, Record of Transactions.
Kew Gardens Bulletin.
Lima, Cuerpo de Ingenieros de Minas, Boletin.
Linnean Society, Journal.
Lisbon, Sociedade de Geographia, Boletim.

Liverpool, Engineering Society, Transactions.
———, Institute of Tropical Research, Journal.
——— Literary and Philosophical Society, Proceedings.
London Chamber of Commerce, Journal.
Lyon, Société d'Agriculture, Sciences et Industrie, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
——— Municipal School of Technology, Journal.
——— Steam Users' Association, Reports.
Milan, Associazione Elettrotecnica Italiana, Atti.
Munich, Polytechnischer-Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Indian Association, "The Indian Magazine and Review."
National Service League, Journal.
New South Wales, Institute of Architects, Journal.
———, Royal Society, Journal and Proceedings.
New York Academy of Sciences, Annals and Memoirs.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Nova Scotian Institute of Science, Transactions.
Paris, Comité International des Poids et Mesures, Procès Verbaux.
——, Conservatoire National des Arts et Métiers, Annales.
——, Société d'Encouragement pour l'Industrie Nationale, Bulletin.
——, Société de Géographie Commerciale, Bulletin.
——, Société des Ingénieurs Civils, Mémoires.
——, Société Internationale des Electriciens, Bulletin.
——, Société Nationale d'Acclimatation de France, Bulletin.
Patent-office, Illustrated Official Journal.
Pennsylvania (Western), Engineers' Society of, Proceedings.
Philadelphia, Academy of Natural Sciences, Proceedings.
——— Engineers' Club, Proceedings.
Physical Society, Proceedings.
Quekett Microscopical Club, Journal.
Röntgen Society, Journal.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Dublin Society, Proceedings and Transactions.
Royal Geographical Society, "The Geographical Journal."
Royal Horticultural Society, Journal.
Royal Institute of British Architects, Journal.
Royal Institution of Cornwall, Journal.
Royal Institution of Great Britain, Proceedings.
Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal and Record.
Royal National Life Boat Institution, "The Life Boat" and Annual Report.
Royal Photographic Society of Great Britain, "The Photographic Journal."
Royal Sanitary Institute, Journal.
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Smithsonian Institution, Report and Publications.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Cymmrodorion, Magazine.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
Society of Public Analysts, "The Analyst."
South Wales Institute of Engineers, Proceedings.
Tramways and Light Railways Association, Official Circular.
Victoria Institute, Journal of the Transactions.
Wisconsin Academy of Sciences, Transactions.

JOURNALS.

Weekly.

Amateur Photographer.
American Architect and Building News.
American Gas Light Journal.
American Machinist.
Architect.
Automotor.
Board of Trade Journal.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Building News.
Cabinet Maker.
Chemical News.
Chemist and Druggist.
Chronicle (Montreal).
Chronique.
Colliery Guardian.
Cosmos: Revue des Sciences
Economist.
Electrical Engineer.
Electrical Engineering.
Electrical Industries.
Electrical Review.
Electrical Times.
Electrician.
Electricity.
Engineer.

Engineering.
Engineering Record (New York)
English Mechanic.
Gardeners' Chronicle.
Gardening World.
Graphic.
Grocer.
Indian Engineering.
Iron and Coal Trades Review
Journal of Gas Lighting.
Journal of Horticulture.
Lancet.
Mechanical Engineer.
Medical Press and Circular
Millers' Gazette.
Mining Journal.
Moniteur Industriel.
Musical Standard.
Nature.
Notes and Queries
Page's Weekly.
Pharmaceutical Journal.
Photography.
Practical Engineer.
Produce Markets' Review
Public Opinion.
Queen.
Railway Times.
Revue Industrielle.
Royal Automobile Club Journal.
Sanitary Record.
Saturday Review.
Science.
Scientific American.
Shipping World
Spectator.
Sphere.
Surveyor.
Textile Mercury

Fortnightly.

Agricultural News (Barbados).
Brewers' Gazette.
Corps Gras Industriels.
Finance Chronicle.
Irish Builder.
Jeweller and Metalworker.
Madrid Cientifico.
Perak Government Gazette.
Quinzaine Coloniale.
Railways (Calcutta).
Revue du Travail (Brussels).
West India Committee Circular.

Monthly.

Agricultural Bulletin (Singapore).
American Exporter (New York).
American Silk Journal.
Architectural Review.
Arms and Explosives.
Board of Agriculture Journal.
Bookseller.
Brewers' Journal.
British Trade Journal.
Building Societies' Gazette.
Caterer and Refreshment Contractors' Gazette.
Coach Builders' and Wheelwrights' Art Journal.
Cold Storage and Ice Trades Review.
Commercial America.
Concrete.
Co-partnership.
Cotton (Atlanta).
Councils' Journal.
Decorator.
Dyer and Calico Printer.
Educational Times.
Electrical Magazine.
Engineering Magazine.
Engineering Review.
Estate Magazine.
Fotografia Artistica (Turin).
Foundry Trade Journal.
Gas and Oil Power.
Giornale del Genio Civile (Rome).
Ice and Cold Storage.
Illuminating Engineer.
Indian and Eastern Engineer.
Indian Review (Madras).
Indo-European Commercial Intelligence.
Inland Printer (Chicago).
International Sugar Journal.
Investors Monthly Manual.
Journal d'Agriculture Tropicale.
Journal d'Hygiène.
Leather Trades' Review.
Machinery Market.
Marine Engineer.
Mask.
Mercantile Guardian.
Miller.
Mois Scientifique et Industriel.
Moniteur Scientifique.
Musical Times.
Oesterreichische Monatsschrift für den Orient.
Paper Makers' Monthly Journal.
Philosophical Magazine.
Photographic Monthly.
Photographic Times (New York).
Physical Review.
Plumber and Decorator.
Pottery and Glass (New York).
Pottery Gazette.
Process Engraver's Monthly.
Propriété Industrielle (Berne).
Revue Mineralurgique.
Science Abstracts.
Scientific Monthly.
South African Engineering.
Symons's Meteorological Magazine.
Textile Manufacturer.
Textile Recorder.
Watchmaker, Jeweller, and Silversmith.

Water.
Western Architect (Minneapolis).
Woodworker.
World's Carriers.

Quarterly.

Agricultural Journal of India.
Art Workers' Quarterly.
Colonial Office Journal.
Edinburgh Review.
Quarterly Review.
Reliquary.
Transvaal Agricultural Journal.
West Indian Bulletin.

NEWSPAPERS.

African Mail.
African World.
Banbury Advertiser.
Bombay Gazette (Overland Summary).
British Australasian.
Ceylon Observer (Overland Edition).
Englishman (Calcutta).
Hindu (Madras).
Home and Colonial Mail.
London Commercial Record.
London and China Telegraph.
Madras Weekly Mail.
Newcastle Weekly Chronicle.
Nottinghamshire Guardian.
Pioneer Mail (Allahabad).
Shipping Gazette and Lloyd's List (Weekly Summary).
South Africa.
Times of Ceylon (Weekly Summary).
Times of India (Overland Weekly Edition).

INDEX TO VOL. LVI.

D.

E.

I.

K.

L.

T.

U.

V.

10 R.S.

W.

Y.

Z.

PRINTED BY WILLIAM TROUNCE, 10, GOUGH-SQUARE, FLEET-STREET, LONDON, E.C.